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Particles and Fields—Magnetosphere

5720 Interactions between solar wind and magnetosphere

IMF B_y-DEPENDENT PLASMA FLOW AND BIRKELAND CURRENTS IN THE DAYSIDE MAGNETOSPHERE 1. DYNAMICS EXPLORER OBSERVATIONS

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Plasma, magnetic-field and DC electric-field observations from Dynamics Explorers 1 and 2 are used to investigate the morphology of solar-wind ion injection, Birkeland currents, and plasma convection in the morning-sector for both positive and negative IMF B_y components. The results of the study are used to construct a B_y-dependent global convection model for southward IMF. A significant element of the model is the coexistence of three types of convection cells ("merging cells," "viscous cells," and "lobe cells"). This model can account for observations of a nearly stationary (in local time) convection "throat," a sunward-antisunward convection reversal zone at the polar-cap boundary in both the morning and afternoon quadrants, the morphology of solar-wind ion injection and transport in the mid-altitude polar cusp, and B_y-dependent dawn-dusk asymmetry of polar-cap electron fluxes. (Particle measurements, electric fields, convection).

J. Geophys. Res., A, Paper 4A1063.

5733 Magnetic storms

SOLAR WIND PARAMETERS AND GEOMAGNETIC STORMS

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We employ two independent methods to determine the relationship between the ε parameter and the total energy dissipation rate of the magnetosphere by selecting disturbed periods from the same data set used by Baker et al. (1983). Specifically, four storms are examined in detail, since the accuracy of estimating U_T is significantly improved during disturbed periods. The first method assumes $U_T = M_A^{\alpha}\,\varepsilon$, where M_A is the Alfvén Mach number and α varies with time. The second method considers a linear, time-invariant dynamic system with ε as input and U_T as output. This means $U_T = W * \varepsilon$ where $*$ is convolution and W is the transfer function characteristic of the system. It is found that α values fluctuate mainly between 0 and -0.25. The transfer function analysis indicates that W often resembles a δ-function or a narrow rectangular impulse. Both results give the same implication (namely, $U_T \sim \varepsilon$) and thus are consistent with the view that the magnetosphere is primarily a directly driven system during disturbed periods. (Solar wind parameters, geomagnetic storms)

J. Geophys. Res., A, Paper 4A8151.

5755 Plasma instabilities

TAIL FIELD EFFECTS ON DRIFT MIRROR INSTABILITY

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The effects of geomagnetic tail fields on drift mirror instability are studied for a magnetic field model that contains a magnetic gradient and a tail field perpendicular to an ambient field. The magnetospheric plasma is assumed to consist of a cold component and a high β anisotropic inhomogeneous component. The gyro-kinetic equations are used to derive the dispersion equation including the effects of magnetic gradient and curvature drifts. The dispersion equation is solved locally for wave frequencies less than the ion gyro-frequency. The numerical results indicate that the instability growth rate decreases when the tail field strength increases. The drift mirror instability is found to be stablized when larger tail fields require a smaller pressure anisotropy and a smaller plasma β_i to maintain equlibrium. The theoretical results are used to explain the GOES satellite observations that stormtime Pc5 waves occur less frequently during periods of large tail fields. (Drift mirror instability, tail field, gyrokinetic equation).

J. Geophys. Res., A, Paper 4A8080.

MEASUREMENT OF ANISOTROPIC PERMITTIVITY STRUCTURE OF UPPER TROPOSPHERE WITH CLEAR-AIR RADAR

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When radar echoes are obtained from the upper troposphere, tropopause and lower stratosphere, one characteristic reported by several groups is a variation in echo strength with pointing angle. These observations are interpreted in terms of an anisotropic structure to the permittivity of the air in that region. The present paper attempts to make some quantitative estimates of this anisotropy.

The measurements analyzed were obtained with the SOUSY 50 MHz radar installed in the 1000-foot diameter antenna at Arecibo. Observations were made at eight zenith angles, from 0 degrees to 11.7 degrees, and at two azimuths, north and east. Echo strength as a function of zenith angle was obtained for these two azimuths and for many heights, with a range resolution of 150 meters. These data were then fit to an anisotropic scattering model, and the possible anisotropy parameters were found. Horizontally there was a range of uncertainty between the degree of anisotropy and its orientation. This uncertainty was inherent in the original measurements, since only two azimuths were used. However, despite this latitude, the vertical anisotropy was quite closely determined. For most heights, the ratio of vertical to horizontal correlation distance of the permittivity field was 0.2 or less. (ST radar, troposphere, anisotropy, backscatter).

Rad. Sci., Paper 4S1088.

5755 Plasma instabilities

PATH INTEGRATED GROWTH OF AURORAL KILOMETRIC RADIATION

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Using Poeverlein's graphical method, three-dimensional raypath calculations are performed to evaluate the path integrated growth of auroral kilometric radiation (AKR). The ray tracing results indicate that waves whose initial wave vector lie in the local meridian plane continue to propagate in that plane and that, among these waves, those with frequencies near the cutoff frequency ($f_{R=0}$) refract substantially, whereas those with frequencies well above the cutoff frequency suffer little refraction. It is also shown that waves whose initial wave vector lie outside of the local meridian plane propagate in the longitudinal as well as the radial and the latitudinal directions. The refraction of these waves is also highly dependent upon the wave frequency, i.e., waves with frequencies near $f_{R=0}$ refract substantially, whereas waves with frequencies much above $f_{R=0}$ undergo little refraction. In order to test the electron cyclotron maser mechanism as a method for generation of AKR, a typical electron distribution function, measured in the auroral zone by the S3-3 satellite, is used to calculate path integrated growths of representative rays. The results of this study indicate that electron distribution functions like those measured by the S3-3 satellite are not capable of amplifying cosmic noise background to the observed intensities of auroral kilometric radiation, and that much steeper slopes $\left(\frac{\partial f}{\partial v_\perp}\right)$ at the edges of the loss cone are required. The presence of such distribution functions in the auroral zone is plausible if one assumes that backscattered electrons in this region have energies less than a few hundred eV.

J. Geophys. Res., A, Paper 4A8069.

5776 Trapped Particles

DIURNAL MODULATION OF THE QUIET-TIME PENETRATING ELECTRON FLUX

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Three sounding-rocket measurements of energetic electron precipitation in the 65-80 km altitude range above Siple Station, Antarctica, suggest a possible diurnal modulation of the precipitation. Flights made on January 10 and 11, 1981 to investigate this possibility showed that no electrons were present after local noon while a significant flux of penetrating electrons was observed the following day near local dawn, even though the level of magnetic activity was higher during the post-noon flight. A previous flight from Siple Station also observed a large flux of penetrating electrons near local dawn. Calculations of electron drift trajectories in a model magnetic field indicate that moderate values of the convection electric field could cause significant local time variations in the penetrating electron flux at the western edge of the South Atlantic anomaly. These calculations indicate that Siple Station is "shadowed" by eastern Siberia when it is at local noon, but not when it is at local dawn.

J. Geophys. Res., A, Paper 4A8123.

GEOSCOPE: A French Initiative in Long-Period Three-Component Global Seismic Networks

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Introduction

Progress in long-period seismology has been considerable in the past few years, owing to the availability of digital data from well-calibrated worldwide instruments. The very long period International Deployment of Accelerometers (IDA) network [*Agnew et al.*, 1976] has provided many new measurements concerning both earth structure and seismic source studies and demonstrated the usefulness of sparse global digital networks. The broadband Global Digital Seismographic Network (GDSN) network has given access to a large quantity of data whose exploitation can be readily automatized.

Both networks have their shortcomings, however, now expressed in the desire of many U.S. scientists to develop a new global digital network better adapted to present requirements of geophysical research. In the very long period domain (periods from about 100 s to 1 hour), the IDA network only records the vertical component of ground motion, making information from horizontally excited modes of the earth unavailable. It also saturates the first Rayleigh wave trains from the largest earthquakes, causing a loss of data on direct source station paths, regrettable both for source and structure studies. The GDSN network suffers from some nonlinearity problems and, above all, the inadequacy of instrument responses for present needs of seismologists: The Seismic Research Observatories (SRO) network [*Peterson and Orsini*, 1976], which is the main constituent of GDSN, was designed mainly for discrimination between earthquakes and nuclear explosions.

In the past few years, improvements in technology, in Europe in particular, have led to the design of easy to handle, robust, well-calibrated, three-component broadband seismometers, with built-in flexibility and multiplicity of instrumental responses and a large dynamic range [*Wielandt and Streckeisen*, 1982]. Progress has also been made in the design of digital recording systems with the advent of microprocessor technology and the increased capacity of magnetic recorders of low power consumption. It thus became possible to embark on the design of a new global long-period digital network that would complement the existing ones with improved capabilities and original station locations.

At the Institut de Physique du Globe (IPG) in Paris, we felt well prepared for this enterprise, given our long-term experience in long-period seismology [*Jobert and Roult*, 1976; *Jobert et al.*, 1977], instrumentation, digital recording, and data processing [*Blum and Jobert*, 1959; *Blum and Gaulon*, 1971] as well as our access to original sites through the numerous scientific cooperation programs that France maintains worldwide.

GEOSCOPE Project: Specifications

After a period of experimentation with the Wielandt seismometers in our Saint-Sauveur Observatory in the center of France [*Roult*, 1982], this project came to life in 1981 as a joint effort of the IPG in Paris and Strasbourg, sponsored by INAG (Institut National d'Astronomie et de Geophysique). It was first meant to be a three-component very long period (VLP) network to fill gaps in the geographical distribution and remedy the lack of horizontals of the IDA network. For purpose of comparison, an IDA instrument was run in parallel with the Wielandt vertical seismometer at Saint-Sauveur for a period of 1 year starting in October 1981. The comparative study of performances and especially of noise had shown that similar noise levels are to be expected from both instruments with the advantage of wider dynamic range for the Wielandt seismometer [*Romanowicz and Agnew*, 1984].

It soon appeared, under the pressure of new developments in the field of digital seismology, that the potential of the instruments was not being used at its best, and that with little additional effort the broadband (BRB) output inherent to the seismometers could also be recorded to satisfy the needs of research in the period range 1–100 s. If three-component VLP channels provide basic data for large earthquake investigations and for the study of large-scale processes in earth physics, the BRB outputs are of fundamental importance in obtaining finer details both in source and in structure studies. They open the field of body wave and surface wave seismology, allowing us to apply most of waveform modeling techniques to the records to be provided by the network. Furthermore, the recording of the BRB channels will be important for participation in the collection of regional data in connection with more local networks.

The Wielandt-Streckeisen seismometers can provide signals up to 5 Hz. The BRB output is, for example, recorded at 20 samples per second in the Graefenberg array [*Harjes and Seidl*, 1978]. There is, however, a stringent constraint for the GEOSCOPE project: Most remote stations should have recording facilities with an autonomy of at least 1 week. Our philosophy is to use well-tested technology that has proved high performance in remote sites. Owing to the storage capacity of low power consuming recorders presently available, this forces us to (1) use event detection for the BRB output and (2) limit the sampling rate to five samples per second. If the magnitude threshold is fixed to about six, worldwide, allowing for additional triggering by possible small magnitude events and if the recording length per event is fixed to 2 hours, five samples per second appears to be the upper limit.

Thus the specifications of the network presently retained are as follows: About 20–25 stations worldwide, each equipped with a three-component set of Wielandt seismometers, and a digital recording system of low power consumption, providing data simultaneously in two-frequency bands: (1) VLP (very long period), with continuous recording at a sampling rate of 10 s; (2) BRB (broadband), recording on event detection for 2 hours, with a sampling rate of five points per second in the present experimental stage.

The instrument response curves of both channels are shown in Figure 1. When the more powerful technology presently under development has proved its performance in the field, it will be possible to update the system to fully use the capabilities of the seismometer. The seismometers have been described in detail by *Wielandt and Streckeisen* [1982]. The vertical is a leaf spring feedback seismometer of 20-s natural period; the horizontals are simple pendulums with 10-cm boom length. All have a very small size and are well shielded from pressure and temperature variations by void glass jars and several layers of insulating materials. Their dynamic range is about 140 dB at the output of the analog units.

Two recording systems are presently being tested. The first one has been designed by G. Streckeisen. It records on digital magnetic cartridges with a capacity of 1–2 million samples and has gain ranging dynamic range of about 114 dB. A second system has been developed independently at IPG in Strasbourg. It is derived from a low power consuming PCM acquisition system which has been developed for a mobile network of portable short-period stations; 400,000 samples can be easily stored on a 1-hour regular audio tape (305 m)in the system currently being tested in the GEOSCOPE station in Kerguelen. The dynamic range of the recording system is presently 114 dB. Both systems are designed to be well adapted to installation in remote, uncomfortable sites.

While these systems are being tested, most stations are temporarily equipped with a simple DATEL cassette recorder. This restricts us for the time being to recording only the VLP channel on all three components. The station at SSB has just been equipped with the new Streckeisen recording system, and the station at Kerguelen Islands (PAF), benefiting from nine-track tape recording facilities, also records a very long period channel with a broadened response to higher frequencies, called HGLP, as well as the vertical BRB channel at a rate of one sample per second.

The data are sent back via airmail to the IPG in Paris (through Strasbourg in the case of station PAF), where a data center is being equipped, to unpack, verify, and transfer the data to nine-track tapes for distribution to potential users worldwide. The format for the final nine-track tapes is a hybrid between the IDA and GDSN formats, which should make retrieval of data as simple as possible. Real-time transmission of data is currently under study, in cooperation with INAG. An experimental system is currently being installed at Saint-Sauveur (SSB).

Present Status of the Network

The three stations now running for over a year are SSB (Saint-Sauveur, France), PCR (La Reunion, Indian Ocean), and PAF (Kerguelen Islands). The network counts five operational stations as of May 15, 1984: One has been installed in October 1983 in Tamanrasset (Algeria), in cooperation with the ONRS, and another one has been installed in Wallace Observatory (Cambridge, Mass.) in cooperation with the Massachusetts Institute of Technology. Figure 2 shows the geographical distribution of the existing and planned stations. By the end of 1984, eight stations should be in operation. In addition to the stations installed by France, stations equipped with Wielandt seismometers by Eidgenössische Technische Hochschule (ETH) (Zurich) will be upgraded to join the GEOSCOPE network (Azores, Iceland, and possibly western Canada), when the digital recording system, now in an experimental stage, will have reached its final version.

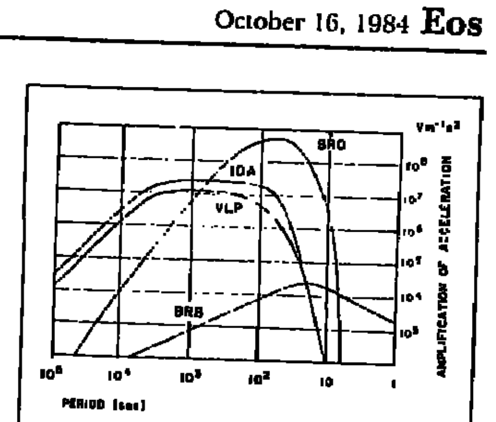

Fig. 1. Instrument response curves of Wielandt VLP and BRB channels as compared to IDA and long-period SRO responses.

For the years 1985–1986 we plan to install more stations in sites easily accessible for France (Tahiti, Dumont d'Urville in Antarctica) or in cooperation with other countries, as is presently the case for Algeria and the United States.

So far, the sites installed have benefitted from pre-existing facilities, mostly seismic observatories, which have not required the building of vaults and the design of data transmission systems to removed recording sites. In the stations planned for 1984, Djibouti, French Guyana, and Noumea, this is necessary. A seismic vault has already been built in Djibouti. Sites are carefully chosen to be shielded from winds and other atmospheric perturbations, but for the time being we do not intend to bury the instruments in depth.

Scientific Potential of the Network

Recent observations of eigen periods and attenuation of spheroidal modes from the IDA network have led to the improvement of average earth models but also to the discovery of specific patterns of *S* velocity heterogeneity in the upper mantle and transition zone [*Silver and Jordan*, 1981; *Masters et al.*, 1982]. Regionalized models of the earth have been improved in the past few years by using data from the IDA network [*Dziewonski and Stein*, 1982] and from other digital stations, in particular stations installed in the past in France and the Pacific Ocean by IPG [*Blum and Gaulon*, 1971; *Jobert et al.*, 1979; *Lévêque*, 1980]. Recently, maps of lateral heterogeneity in the mantle have been obtained from low-order spherical harmonic expansion of phase velocity data from the IDA, GDSN, and Worldwide Standard Seismograph (WWSSN) networks [*Nataf et al.*, 1984a; *Souriau and Souriau*, 1983; *Dziewonski and Woodhouse*, 1984]. On the other hand, attempts at resolving the question of anisotropy in the upper mantle as raised by the PREM model [*Dziewonski and Anderson*, 1981] and many regional surface wave studies, including overtones [*Lévêque and Cara*, 1983], have been promising [*Journet and Jobert*, 1983].

S velocity and its anisotropy are two parameters whose heterogeneity plays a key role in geodynamics. *S* velocity can be related to density, which governs mantle dynamics, while anisotropy can be related to lines of convective flow; in other words, to mantle kinetics.

While many more interesting results are to be expected from the existing digital networks, some of their limitations make the project GEOSCOPE attractive and necessary.

To attain a better resolution of lateral heterogeneity, a better distribution of stations is necessary. This means more stations but also a more homogeneous distribution around the earth. From this point of view, GEOSCOPE stations in the Indian Ocean and South Pacific are bound to play a decisive role.

To reduce the uncertainty in the odd order terms of spherical harmonic expansions of *S* velocity, it is necessary to be able to use surface and mantle Rayleigh wave trains in direct source station paths. With a large dynamic range, the GEOSCOPE instruments are well suited to this purpose. To study anisotropy, one must analyze simultaneously Love and Rayleigh wave trains. The three-component configuration of GEOSCOPE stations is again appropriate. It is also the case for depth resolution of *S* velocity heterogeneities. Figure 3 shows examples, on the longitudinal components, of phases rich in long-period Rayleigh wave overtones (X phases) at two different GEOSCOPE stations and for two different events. Regionalization of such overtones will notably increase spatial and depth resolution of heterogeneities [*Okal and Jo*, 1983], whose study was until now practi-

Article (*cont. on p. 754*)

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Editorial

A Change for Reviews

AGU's review journal, *Reviews of Geophysics and Space Physics*, began 20 years ago with the title *Reviews of Geophysics*. In 1970 the title was changed to *Reviews of Geophysics and Space Physics* (RGSP). By AGU Council action in December 1983, the title will revert to *Reviews of Geophysics*, effective 1985.

With the growing number of geophysics articles published each year, review journals have an ever more important role to play, and they must be continually reevaluated to see if they meet their responsibility. In a comparison of the types of papers published in this journal for the years 1979–1982, and in a comparison of AGU membership according to section, one sees the results given in the table.

This suggests that we have an imbalance in the types of papers published. More papers are needed from members of the Hydrology, Ocean Sciences, Tectonophysics, and some other sections while the good flow of papers is kept up from the Atmospheric Sciences, Planetology, SPR, and other sections.

By allowing the name of the journal to revert to *Reviews of Geophysics*, in agreement with the name of our Union, we remove any shadow of a doubt that all types of articles are welcomed and needed by this review journal. We hope that members in those sections of AGU which were underrepresented will be further encouraged to submit reviews.

It takes more than a name change to change the nature of a journal, and we hope the readership will appreciate the effort that the editorial staff is now making to promote timely and comprehensive reviews across the full range of our interests.

J. R. Heirtzler
Editor, Reviews of Geophysics and Space Physics

Section	Papers in RGSP, %	AGU Membership, %
Geomagnetism and Paleomagnetism	4.9	4.8
Geodesy	8.3	5.7
Seismology	6.9	10.0
Atmospheric Sciences	17.4	6.8
Ocean Sciences	9.7	13.4
Volcanology, Geochemistry, and Petrology	8.5	10.2
Hydrology	0.7	17.0
Tectonophysics	0.7	9.5
Planetology	14.6	4.7
Solar-Planetary Relationships	26.4	11.5

Article (cont. from p. 753)

cally limited to the analysis of the fundamental mode alone, for example, in oceanic areas [Montagner and Jobert, 1981, 1983]. With this perspective the hope is raised that it will soon be possible to obtain information of primary importance on the convective regime within the mantle of the earth.

Owing to the broadening of the frequency band up to 1 Hz, the GEOSCOPE records will permit the study of smaller-scale structures. Long-period body wave modeling is particularly well suited to investigate mantle transition zones, and body wave correlation techniques, as used by *Stark and Forsyth* [1983], will permit the investigation of deep lateral variation of velocity. Figure 4 shows an example of long-period body waves recorded in the Kerguelen station. The structure of the lithosphere and, in particular, the question of possible coupling between seismic thickness of it and anisotropic parameters, as raised by *Anderson and Regan* [1983], could be properly addressed by making full use of Love and Rayleigh wave data provided by the three-component broadband output of the GEOSCOPE network.

Progress has also been considerable in the past few years in the domain of long-period source studies, owing to the rapid analysis made possible with the availability of digital data.

Source parameters for the larger earthquakes that have occurred in the past 5 years have been retrieved from the IDA network [*Kanamori and Given*, 1981; *Silver and Jordan*, 1983], yielding information on the long-period behavior of the sources. It appears that in many cases an estimate of depth of source can also be obtained from very long period data alone [*Romanowicz and Guillemant*, 1984]. Waveform modeling of the first tens of minutes of the long-period GDSN records has also permitted to complement the automatic compilation of first-arrival data by information on source parameters and depth of relatively small earthquakes [*Dziewonski et al.*, 1981].

The new data that GEOSCOPE can provide will increase the resolution in long-period source studies by complementing azimuthal station distribution and, again, providing three-component data on the first Rayleigh and Love wave trains. Source studies using body waves will also benefit from the availability of broadband data. For example, *Choy and Boatwright* [1981] have shown how increasing the frequency band of the signal toward shorter periods is important for the study of variation with frequency of attenuation and details of seismic sources, such as directivity and rupture process. To achieve this, seismists have to combine long- and short-period records, a disputable process which can be avoided with the broadband data provided by GEOSCOPE.

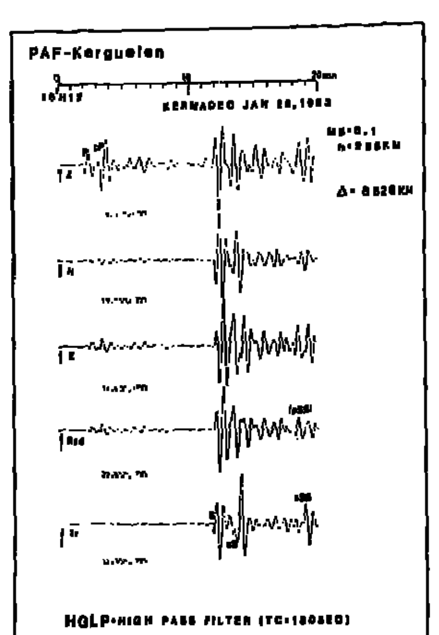

Fig. 4. Example of long-period body waves recorded in the GEOSCOPE Kerguelen station (PAF).

Conclusion

The GEOSCOPE network represents a new experiment in global networks that incorporates to date technological achievements and is geared toward satisfying the requests of present-day geophysical research. As such, it is bound to become a basic tool of seismologists in the next 10–20 years.

Out of 20–25 stations planned in the next 5 years, five are operational, and three more will be installed by the end of 1984. With its present setup of international cooperation (e.g., that planned with ETH in Zurich), we hope that GEOSCOPE will become the core of a denser future international network, with Contributions from several other countries.

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Barbara A. Romanowicz *received her Doctorat d'Etat in Geophysics from the University of Paris in 1979. After completing two years as a postdoctoral fellow at the Massachusetts Institute of Technology, she returned to Institut de Physique du Globe in Paris, where she is now heading the GEOSCOPE project. Her research interests have included large-scale studies of upper mantle structure using body wave data, regional studies using surface waves, and more recently, seism source studies at intermediate and very long periods.*

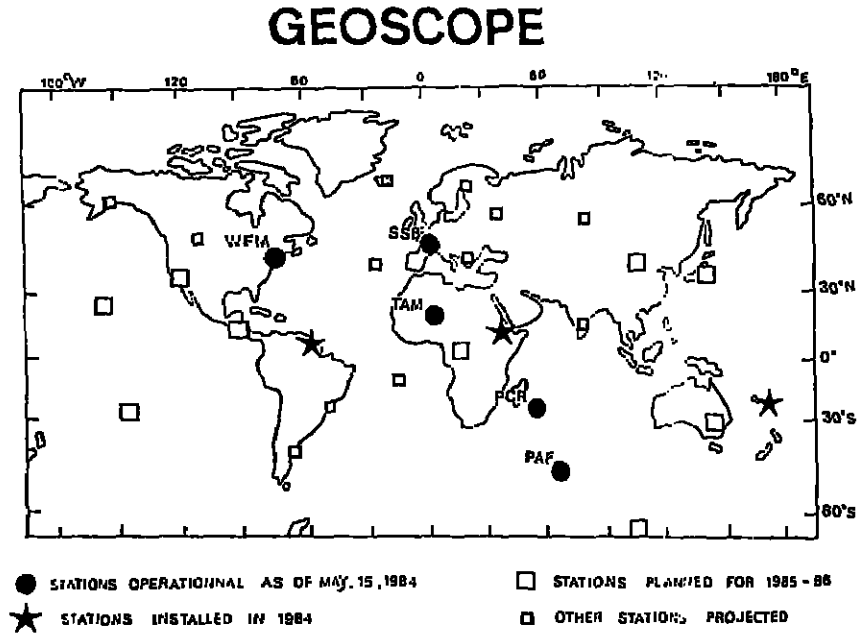

Fig. 2. Geographical distribution of GEOSCOPE stations in operation and planned. Sites for stations planned beyond 1984 are hypothetical.

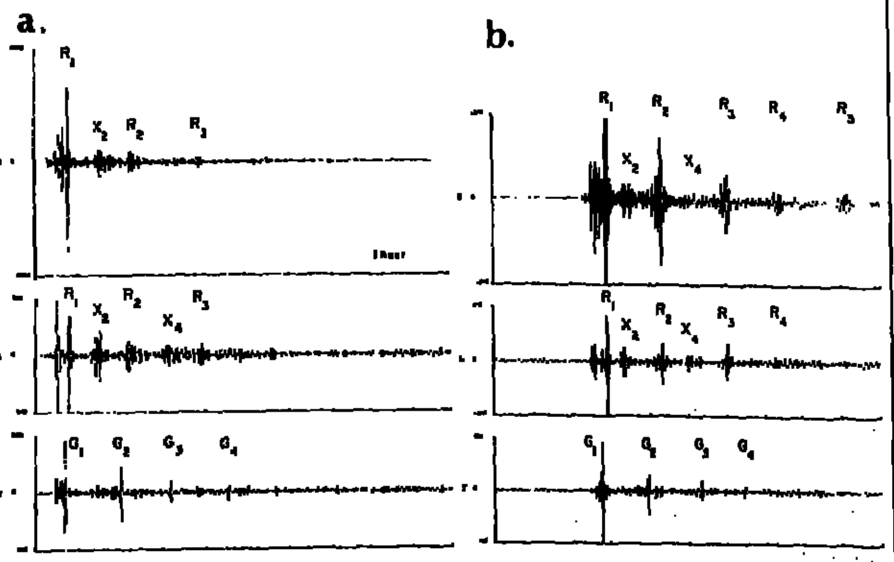

Fig. 3. Records at two stations of two large events in 1983, on the VLP channel. Horizontals have been band pass filtered (100–500 s) and rotated to yield longitudinal and transverse components

News

Melting Diamonds

For the first time, scientists have documented the direct melting of diamond, the hardest known substance. The evidence may help confirm theories that carbon is in a liquid state at the high pressures and temperatures of the earth's interior. Evidence of melting had been discovered previously only when graphite was used as the starting material.

Four geologists at Cornell University were conducting mineralogy experiments in which temperature and pressure conditions of the earth's interior are simulated using a yttrium-aluminum-garnet (YAG) laser as a heat source and a diamond anvil cell, capable of generating pressures greater than 450,000 times atmospheric pressure at sea level, containing a mixture of potassium bromide and graphite. During the course of the research last February, the laser was inadvertently run at a higher power density than planned and caused damage to the face of the diamond anvil.

Closer examination of the anvil revealed a small, smooth furrow about 0.1 mm long (Figure 1). According to the scientists, reporting in the August 31 issue of *Science*, small droplets of potassium bromide were suspended below the surface of the furrow. Further examination showed that the droplets were completely encapsulated in the melted and resolidified diamond, evidence that melting had actually taken place. "Fracturing would not produce such smooth surfaces, graphitization would not produce transparent material, and oxidization would result in missing rather than redistributed material," wrote researchers Jon S. Gold, William A. Bassett, Maura S. Weathers, and John M. Bird.

After realizing what had happened, the team repeated the experiment without using

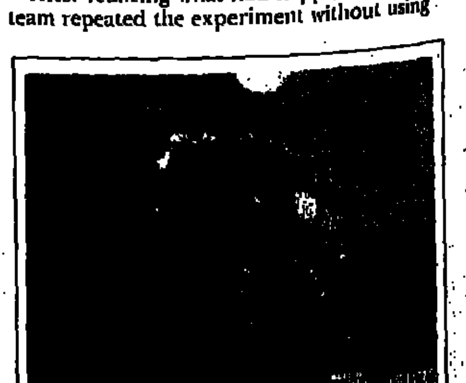

Fig. 1. Scanning electron micrograph reveals small furrow in face of the diamond anvil (photo courtesy of Cornell University).

graphite. Although a much higher temperature was needed, the initial results were duplicated. The researchers theorize that the graphite might play a role in initializing the melting of diamond. The geologists will next attempt to measure the temperature of the diamond for the instant (20 nanoseconds) that it is in a liquid state.

Quake Research Proposals Solicited

The U.S. Geological Survey invites proposals for research contracts and grants under the continuing Earthquake Hazard Reduction Program. The proposed research must be directed toward the goal of identifying, evaluating, and characterizing the immediate and long-term seismic hazard. Program objectives and tasks required to achieve those objectives are described in Proposal Information Package RFP-1586.

Written inquiries concerning this program and requests for Proposal Information Package RFP-1586 should be addressed to Contracting Officer, U.S. Geological Survey, MS 285, 345 Middlefield Rd., Menlo Park, CA 94025. Proposals will be due in early February 1985. It is anticipated that funding of selected programs will start on or after October 1, 1985.

This news item was contributed by J. H. Pfluke, *Office of Earthquake Studies, External Research Program, U.S. Geological Survey, Menlo Park, Calif.*

NSF Fellowships

The National Science Foundation (NSF) has announced that 650 fellowships will be awarded next spring for advanced study in science, mathematics, and engineering, including interdisciplinary and multidisciplinary areas. The fellowships are available to citizens and nationals of the United States and will be awarded on the basis of merit for full-time study. Fellowships are available in three categories, including 540 graduate fellowships, 60 minority graduate fellowships, and 50 North Atlantic Treaty Organization (NATO) postdoctoral fellowships.

The graduate fellowships include a stipend of $11,000 for a 12-month tenure and a cost-of-education allowance of up to $6,000 per year to be provided to the educational institution in lieu of tuition and fee charges. These fellowships are renewable for up to 3 years, depending on availability of NSF funds. Application deadline is November 21. Fellowships will be awarded mid-March 1985. For more information and applications, contact the Fellowship Office, National Research Council, 2101 Constitution Ave., Washington, DC 20418 (telephone: 202-334-2872).

The minority graduate fellowships are available to students who are members of minority groups. Minority students may also apply for the fellowships described above. The application deadline is also November 21, and awards are also expected in mid-March. Information, including other eligibility requirements and applications, is available from the above address and phone number.

The NATO Fellowships are available for study outside the United States in a NATO member country or a neighboring country cooperating with NATO. A stipend of $1,500 per month for periods up to 12 months and limited travel and dependency allowances are provided. Applications must be submitted by November 1. Awards will be announced in late February 1985. Further information and applications are available from the Office of Research Career Development, Directorate for Science and Engineering Education, National Science Foundation, Washington, DC 20550 (telephone: 202-357-7536).

NSF is also offering postdoctoral fellowships in mathematical sciences and plant and environmental biology. For information on mathematical sciences, contact Alvin Thaler, Division of Mathematical Sciences, NSF (telephone: 202-357-9764); for plant biology, contact H. T. Huang, Division of Molecular Biosciences, NSF (telephone: 202-357-9782); for environmental biology, contact William J. Riemer, Division of Biotic Systems and Resources, NSF (telephone: 202-357-7332).

EOS

Transactions, American Geophysical Union

The Weekly Newspaper of Geophysics

For speediest treatment of contributions, send three copies of the double-spaced manuscript to one of the editors named below and one copy to AGU.

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Washington, DC 20009

Cover. Artist's stylized representation of some highlights of San Francisco, host to AGU's 1984 Fall Meeting. Timeless and pleasing—with fine restaurants, temperate December climate, and the charms of Chinatown, Ghirardelli Square, Fisherman's Wharf, Nob Hill, and North Beach—San Francisco is an elegant city and an ideal backdrop for AGU's scientific sessions. This year's meeting will be held December 3–7 at the Civic Auditorium. Housing reservation deadline is October 31; Meeting preregistration deadline is November 9. See Session Summary and Housing and Registration forms in this issue. (Cover designed and drawn by Dae Sung Kim.)

Science Employment

Rapid growth in private sector high-technology companies coupled with the expected unprecedented U.S. peacetime defense buildup paint an optimistic picture for future employment in scientific and engineering fields, according to forecasts by the National Science Foundation (NSF). Between 1982 and 1987, up to nearly 750,000 new positions will be created in scientific, engineering, or technical fields, a new NSF report states. By 1987 these occupations will account for 4 million jobs, or 3.5% of the total U.S. work force. New positions in the earth sciences are predicted to increase about 2% per year.

Computer systems analysis and programing, aeronautical/astronautical engineering, and electrical/electronic engineering will represent the fastest growing segments in which shortages of qualified personnel are expected. The greatest demands will be placed on computer fields, where NSF forecasts that a reliance on new graduates alone would result in a shortfall of 115,000 to 140,000 personnel by 1987. NSF warns that these shortages may lead to an unhealthy dependence on relatively inexperienced or underqualified personnel.

Employment in scientific fields alone is projected to increase at a slower growth rate of 3.0% to 4.1% per year, although this is still twice as high as that predicted for the general U.S. work force. Science and engineering employment has already begun to outpace growth in the general work force. Computer systems analysis will be the fastest growing science occupation, according to NSF. Demand for earth scientists, including geologists, oceanographers, and marine scientists, will also increase by about 2% a year. To a lesser extent, NSF predicts a growth in demand for scientists and engineers in academia as new positions are created "to meet future training needs." Nonmanufacturing industries will maintain their importance in science employment, accounting for one-third of both the predicted growth and total number of personnel in science occupations by 1987.

According to NSF, the study, "Projected Response of the Science, Engineering, and Technical Labor Market to Defense and Nondefense Needs: 1982–87," is the first to account for personnel shifting from one occupation to another as well as new personnel entering the workforce. A set of economic and defense spending characteristics provided the basis for the forecasts: strong versus weak macroeconomic conditions and defense spending levels equal to projected 5-year increases versus levels somewhat lower. According to NSF, performance of the U.S. economy and defense spending during the first year and a half of the study (1982 through mid-1983) tend to support the forecasts. A stronger economy than expected has generally offset slightly slower defense spending.

—*DWR*

New Astronomy Satellite

A new NASA astronomy satellite designed to probe the extreme ultraviolet (EUV) band is scheduled to be launched from the space shuttle in 1988. Called the Extreme Ultraviolet Explorer (EUVE), the satellite's initial objective is to make the first all-sky map in the EUV band of the electromagnetic spectrum, a band between ultraviolet and X ray light.

EUVE, to be stationed in orbit at an altitude of about 550 km, will carry four 40-cm ultraviolet telescopes to be used to conduct the survey and also a spectrometer to carry out detailed observations of new EUV sources and stars.

NASA's Jet Propulsion Laboratory (JPL) will manage the project. The Space Sciences Laboratory of the University of California, Berkeley, will supply the scientific instruments.

Vannevar Bush Award

The National Science Board (NSB) has announced that nominations for the Vannevar Bush Award are now being accepted. The award is given to a scientist who has made outstanding contributions to science and technology through public service activities. Nominations are due January 1, 1985. Information and guidelines are available from the National Science Board, 1800 G St., N.W., Washington, DC 20550.

The award was established in 1980 by the Science Board in commemoration of the 30th anniversary of the National Science Foundation (NSF). Vannevar Bush, acting on advice from President Roosevelt, recommended in 1945 that a foundation be established to be a focal point for the federal government's activities in science and technology. NSF was created 5 years later by Congress.

Geophysicists

Clifford J. Murino has been nominated as a member of the National Science Board. Murino is president of the University Corporation for Atmospheric Research.

Grover E. Murray will become the first honorary member of the American Institute of Professional Geologists (AIPG). Murray is former president of Texas Tech University and Texas Tech University of Medicine. ***Allen F. Agnew***, a geologic consultant and college professor, will receive the institute's 1984 Public Service Award. Both will be honored at AIPG's 21st annual meeting, to be held on October 18 in Orlando, Fla.

Thomas B. Nolan, former director of the Department of the Interior, received a special award for his 60 years of service with the U.S. Geological Survey (USGS). He began working for the USGS as a junior geologist in 1924 after receiving a Ph.D. in Geology from Yale University. In 1956, Nolan became chief of the USGS and eventually served as head of Interior for nine years until 1965. Nolan, now 83 years old, continues to work for the USGS part time as a research geologist.

Manik Talwani has been named recipient of the 1984 George P. Woollard Award of the Geological Society of America. Talwani, chief scientist of Gulf Research & Development Company's Exploration Division, will receive the award in November at the annual meeting of the Geological Society in Reno, Nev.

Thomas B. Nolan

Correction

Because of an editorial error, four references were incorrectly cited in the article entitled "Historic Cartographic Evidence for Holocene Changes in the Antarctic Ice Cover" by John G. Weihaupt, published in the August 28, 1984 *Eos*. In the middle column on page 495, the reference to Figure 3 should be to Figure 2. In the first column on page 496, both references to Figure 4 should be to Figure 3. In the same column, the reference to *Munster*[1540] should be to *Webster*[1982].

Books

It's the Water That Makes You Drunk

Edited by Chris Garrett and Carl Wunsch, *Ref. Ser. 84–5*, Scripps Institution of Oceanography, La Jolla, Calif., 1984.

Reviewed by E. J. Katz

It's the Water That Makes You Drunk is billed as "A Celebration in Geophysics and Oceanography—1982" in honor of Walter Munk's 65th birthday, October 19, 1982. It consists of 14 contributions of variable length and an entertaining autobiographic sketch by the honoree which updates and fills in some Freudian omissions in an earlier autobiography. The authors, an invited group from among the celebrants at a 2-day birthday party, are a diverse group of geophysicists selected to represent the wide spectrum of Walter's scientific interests (and occasional achievements, as Walter himself might say) over the last 4 decades. Thus, among others, Klaus Hasselman writes on surface waves, Chris Garrett on internal waves, Stanley Flatté on sound waves, Carl Wunsch on acoustic tomography, Peter Rhines on the general oceanic circulation, Dave Cartwright on ocean tides, Gordon MacDonald on atmospheric chemistry, Kurt Lambeck on the earth's rotation, and John Tukey on spectral analysis.

Unrestrained by the usual standards of refereed journals, the articles vary considerably in rigor and vigor, but the volume is incontrovertibly a unique birthday present to an incontrovertibly unique oceanographer. The authors tend to give a very personalized history of the developments in their fields over the scientific life span of W. M. and in that lie both the strength and weakness of the volume. As acknowledged leaders of their respective fields, their viewpoints are of much interest. Nevertheless, one should accredit the bulk of the hours spent reading against leisure rather than working time.

We are told that the authors/speakers were given no instructions other than to be witty and profound. One occasionally senses attempts in those directions. For the lack of profundity, we might be thankful; but the general lack of wit which the opportunity invited is disappointing. Perhaps even at a birthday party we are unable to shed the veneer of sobriety so relentlessly imposed on us by humorless editors of professional journals.

Among the articles I found stimulating was that of Hasselman which starts with the (in-)famous *H. O. Publication 601*, by Sverdrup and Munk in 1947, and leads us through three generations of surface wave models that struggle to improve upon the empirical wave prediction models. I appreciated Garrett's passing lightly over the birth and adolescence of the Garrett and Munk universal internal wave spectrum and focusing instead on what initiated the inquiry in the first place: the effect of internal wave breaking on vertical diffusion in the ocean. Lambeck tells the particularly interesting story of geophysicists of various disciplines attempting to assess the effect of perturbations of their media on the earth's rotation. Here oceanography has been well served to have W. M. as our spokesman, who has sought a key in the astronomical data with which to unlock information about the restless ocean that may not be accessible in any other way. Tukey's discussion of overt and covert spectral analysis is a gem.

Historical footnotes and several unabashedly anecdotal articles by Roger Revelle, Henry Stommel, and others try to give us a glimpse of W. M., the man and the scientist. For the most part, they pale when compared to Walter's autobiography. But then, who else thought to describe an unbounded solution as the "Tijuana boundary condition" (topless and bottomless), and then got it into print? He describes his selection of scientific areas of endeavor as determined by his dislike of reading and his fascination with new techniques and instrumentation. The result has been a busy bee, alighting down on one flower after another, cross-pollinating and making honey for the rest of us to savor. However, the novice who might wish to follow this recipe should also keep in mind the moth which is attracted from one light source to another but only succeeds in temporarily cast-

Books (cont. on p. 756)

ing its own shadow. What makes W. M. so ingenuous is that he would be the first to alert the young scientist of just this danger.

A belated happy birthday from all the readers who will enjoy this shared present with you, Walter!

E. J. Katz is with the Lamont-Doherty Geological Observatory, Palisades, NY 10964.

Gas Transfer at Water Surfaces

Wilfried Brutsaert and Gerhard H. Jirka (eds.), D. Reidel, Hingham, Mass., x + 639 pp., 1984, $78.

Reviewed by Georg Matthess

The burning of fossil carbon compounds causes an annual rise of about 0.2% of the total atmospheric CO_2, which is about 50% the annual output of manmade CO_2. One of the major reasons for this beneficial phenomenon is probably the CO_2 uptake by the ocean water. A thorough knowledge of this process is needed for a prediction of the long-term impact of the use of fossil fuels on the environment. The example indicates that mass transfer across the gas-water interface is an important aspect in the geophysical, geochemical, and biochemical cycle of natural and manmade substances. It regulates the transition between the dissolved state in the water and the gaseous state in the atmosphere. The knowledge of the air-water exchange is probably the most advanced of all the transport processes between environmental compartments. Nevertheless, there is still a need for a better understanding of this interfacial mass transfer, which is a critical factor of great scientific and practical relevance in assessments of the various pathways of wastes in the environment and for their engineering management.

This book is based on 59 papers presented at an International Symposium on Gas Transfer at Water Surfaces, held at Cornell University, Ithaca, N.Y., from June 13 to 15, 1983, which was sponsored by the American Geophysical Union and other organizations. The symposium covered a wide variety of physical phenomena involved in gas transfer occurring over a wide range of scales. The exchange mechanisms include diffusion (volatilization or adsorption), deposition in association with particles both dry and wet, dissolution in rainfall, and such complex phenomena as waves, spray, and bubble formation due to the turbulent motion of air and water at their interface. This very complex problem has been approached by scientists from different disciplines and problem areas, such as physical chemistry and chemical engineering, fluid mechanics and hydrology, hydraulics and environmental engineering, geochemistry, oceanography, climatology, and meteorology, often using greatly differing analytical and experimental techniques and methodologies. The cooperation of these different disciplines is not yet well established. Thus, the symposium was intended to provide an open forum for interdisciplinary dialogues and discussion.

The book contains a selection of seven invited and 52 submitted papers organized into the following seven chapters: (1) Physico-chemical Fundamentals, (2) Turbulence Near Gas-Liquid Interfaces, (3) Interfacial Motions and Instabilities, (4) Conceptual Models and Parametrizations of Gas Transfer, (5) Field and Laboratory Experimental Techniques, (6) Climate and Oceanographic Applications, and (7) Water Quality and Engineering Applications. The book is loosely organized because of the lack of a straightforward system for the treatment of the wide range of processes involved in gas transfer and the multi-disciplinary approach to this complex scientific field. There is some overlap in subject matter, which, according to the editors, was "not only unavoidable but actually intentional and desirable." However, the advantage of this overlap, the indication of interconnections between different concepts and approaches, would be more useful for the reader if the editors had provided a subject index. Beyond the inherent weakness of a symposium book, the editors succeeded in presenting a collection of individual papers as a book with good layout, very readable, with a minimum of spelling errors, and generally good figures. Its invited general papers and specialist papers provide good information on the state of the art of knowledge and techniques and of the relevant developments in this field. Most of this information is also important for understanding the processes of gas-exchange at the gas-water interfaces in pore solution and groundwater systems. Thus, this book offers valuable information and is a recommended addition to the libraries of all scientists and engineers working in environmental science and technology.

Georg Matthess is with the Institute For Geology and Paleontology, Kiel University, Kiel, West Germany.

Energetic Ion Composition in the Earth's Magnetosphere: A Volume in the Advances in Earth and Planetary Sciences Series

Edited by R. G. Johnson, D. Reidel, Hingham, Mass., 438 pp., 1983, $93.50.

Reviewed by D. J. Williams

This book originated from 10 invited papers presented at the Symposium on the Role of Ion Composition in Understanding Magnetospheric Processes, which was held in August 1981 in Edinburgh, Scotland. Now, 15 independent papers comprise the volume, of which five are theoretically oriented and 10 are observational in nature, being principally summaries of earlier work.

The opening sentence of this volume begins, "In more innocent times it was believed. . ."—a wonderfully appealing introduction to many an exciting tale of adventure and enchantment. While the remaining prose does not match the spirit of this introductory phrase, the story told collectively by the 15 papers is, in proper perspective, exciting and adventurous. The implied loss of innocence is a reality and was, to my mind, necessary. It was necessary in order to establish a truer observational framework for magnetospheric physics and to get on with the effort of trying to understand this cosmic plasma environment in which we reside. However, the spirit of that early innocence must be kept alive if we are to see the excitement and beauty in the present and future phases of our research.

Now to the present (and less innocent) times and the review. The theoretical papers ranging from general principles to model and simulation calculations are well written, thoughtful, and, in general, very good. Not only are polar wind model calculations and expected atmospheric effects of precipitating O^+ ions presented in detail, but an illuminating discussion of a geophysical analogy to the rich getting richer also is presented (this latter and politically revealing (?) discourse can be found on page 6). However, there are not enough theoretical papers to present a comprehensive review of the role of ion composition information in both determining and diagnosing important magnetospheric physical processes. For example, there is an excellent paper concerning the transverse acceleration of ions on auroral field lines, but there is no similarly detailed theoretical discussion of parallel acceleration of ions on magnetic field lines.

On the other hand, the observational papers do present a comprehensive review of what was known concerning magnetospheric ion composition in early 1982 (the papers were received at the publishing company between February and July 1982). Further, the bulk of the observational papers represent both a major contribution and a testament to the success of the International Magnetospheric Studies (IMS) program, particularly in the area of magnetospheric composition. Prior to the IMS and to the results presented in this volume, initial composition results had been obtained from instrumentation onboard the U.S. Air Force satellite 1971-089a. These very fine results from the Lockheed group showed for the first time the possible importance of the ionosphere as a source of magnetospheric particles. However since these observations were made only in the loss cone of the particle distributions, important questions remained concerning the real importance of the ionospheric source and the relative abundance of specific magnetospheric ions (e.g., H^+, He^+, He^{++}, O^+) throughout the magnetosphere (trapping regions, plasmapause, boundary layers, plasmasheet, etc.).

IMS-related results from the GEOS, ISEE, S3-3, SCATHA, and Prognoz 7 satellites are reviewed in this volume and concern composition measurements generally for particle energies $\lesssim$20 keV/Q (data from the SCATHA satellite are the exception and show oxygen energy densities dominating proton energy densities up to 30 keV during the magnetic storms studied). These satellites, launched in and considered part of the IMS, extended magnetospheric ion composition measurements throughout much of the magnetosphere and yielded the fundamental result that the ionosphere is a major source of magnetospheric particles. In fact, the excellent papers in this volume make it clear that indeed there are two major sources of magnetospheric particles, the solar wind (once considered the sole source) and the ionosphere.

In addition, these papers demonstrate that knowledge of magnetospheric ion composition is fundamental to obtaining a definitive understanding of magnetospheric processes. For example, these papers show that during magnetically active periods, the ionosphere becomes a major and at times a dominant source of particles in the plasmasheet, whereas also during magnetically disturbed periods, the solar wind may become a more important source in the low altitude ring current regions. This indicates that there remains much to be learned concerning magnetospheric particle energization and transport and this learning will require composition measurements in the known key locations in and around the magnetosphere.

In addition to IMS related results on ion composition, there is a summary of solar wind composition, a summary of low-altitude ion composition observations which include ground-based, rocket, and satellite observations, one paper on initial DE satellite results, and a comprehensive review of magnetospheric ion composition at energies $\gtrsim$200 keV/nucleon.

It should be noted (as the editor does) that each author (as often has the reviewer) uses descriptive terms from his own frame of reference such as hot, warm, thermal, suprathermal, energetic, etc., when discussing charged particle observations. Although this projects both a sense of the early innocence referred to previously and a sense of intimacy with the subject matter, it does lead to some confusion as various papers are read and compared; for example, one author's thermal may be another's energetic distribution. Perhaps it is time to become strictly quantitative in describing magnetospheric ions in terms of their observed energies.

In summary, this book is a fine collection of papers dealing with the state-of-knowledge of magnetospheric ion composition in early 1982. The theoretical papers are very good but do not represent a comprehensive overview of the field. The observational papers are also very good and do provide a comprehensive overview of the field at that time.

D. J. Williams is with the JHU/Applied Physics Lab., Johns Hopkins Road, Laurel, MD 20707.

Water Management Models in Practice: A Case Study of the Aswan High Dam

D. Whittington and G. Guariso, Elsevier, New York, 246 pp., 1983, $63.75.

Reviewed by M. T. El-Ashry and D. L. Alford

The stated purpose of this volume is the development and evaluation of operating policies for the Aswan High Dam and their relation to the development of water resources policy in Egypt. That objective is admirably fulfilled through discussions of water use in Egypt and the operation objectives of the High Dam, the behavior of the physical system and simulation of the reservoir, a real-time management model of the dam, management of water shortages and trade-offs between major uses, and coordinated operation of the dam with new upstream as well as downstream developments.

The High Dam has been a source of controversy, particularly with regard to its environmental impacts. Its adverse effects include changes in the water table and attendant salt buildup in irrigated areas, excessive growth of aquatic plants below the dam, shoreline erosion, and increases in water-borne diseases such as schistosomiasis (bilharzia). The dam was intended to offset rapid population growth by increasing food supplies through the transformation of irrigated land in southern Egypt from seasonal to perennial cultivation and by providing water for the reclamation of desert land. Unfortunately, such benefits have been outstripped by the rapidly growing population, and water shortages will be experienced by the end of the century.

The book correctly argues that if Egypt is to expand its cultivated area successfully through an ambitious reclamation scheme, it must (1) increase irrigation efficiency, both on and off the farm; (2) utilize efficient irrigation and drainage technologies; (3) increase the reuse of drainage water; (4) place emphasis on water quality considerations; and (5) initiate better planning for the conjunctive use of ground- and surface water. However, the book also argues that water in Egypt can no longer be treated as a free good. Although farmers in Egypt are not assessed for irrigation water use, it would be difficult to characterize the water as "free," since most irrigation systems are of the "lift" rather than the "gravity" type. In addition, values and collective action based on values have a crucial role to play in reversing trends and in creating social and cultural transformations. In many developing countries, farmers operate on the premise that if a little water is good for the crops, more is better. That is where education, extension, and formal organizations such as water-user associations can play an important role in the efficient use of water.

Development of operational models for the management of multipurpose reservoirs has historically proven to be a difficult undertaking. An ideal model for the management of multipurpose reservoirs would successfully reconcile the variability of the natural hydrologic cycle of the basin with the often conflicting demands for water (e.g., irrigation, power generation, and flood control), together with the political, legal, and socioeconomic issues inherent in each. Lake Nasser is one of the largest multipurpose reservoirs in the world. The water management models discussed for Lake Nasser are based upon a reservoir water budget simulation which uses a simple continuity equation describing input/output relationships. The model uses empirical information derived from a time series analysis of the historical record of the flow of the Nile River at Aswan to forecast input, together with estimates of seepage and evaporation losses to calculate the volume of the reservoir at any given time and thus the allowable discharge. Much of the discussion of the scientific aspects of management models involves an elaboration of the ways in which the data were derived, the confidence that can be placed in them, and modifications required for specific operational problems. The book does not contain, however, a detailed discussion of systems modeling in water resources management.

Shortcomings of the present operational models used for the management of water stored in Lake Nasser are recognized by the authors, and suggestions for improvement are made. However, the book would have benefited from an expanded discussion of the physical controls on the hydrologic regime of the Nile above Aswan. The discussion contained in the book is too cursory to allow the interested reader to do more than speculate on reasons why, using the existing stochastic operational model, "it is difficult to forecast the size of the next flood on the basis of information on previous flows at Aswan" (p. 108). As the authors state, "The answers to such questions can only come from a better understanding of the climatic and hydrological causes of the statistical characteristics of the Nile flows, not from models of more complicated stochastic processes" (p. 107). Yet a detailed discussion of the spatial and temporal variability of these "climatic and hydrological causes" is lacking.

Despite these shortcomings the book makes a valuable contribution to the understanding of the surface water resources of Egypt and the application of water management models in the operation of multipurpose reservoirs. It is well written and, with a couple of exceptions, is well illustrated.

M. T. El-Ashry is a senior associate with the World Resources Institute in Washington, D.C. D. L. Alford is a research associate with the Cooperative Institute for Research in the Environmental Sciences, University of Colorado, Boulder, Colo.

New Publications

Items listed in New Publications can be ordered directly from the publisher; they are not available through AGU.

Andean Magmatism: Chemical and Isotopic Constraints, R. S. Harmon and B. A. Barreiro (Eds.), Birkhauser, Boston, Mass., ix + 250 pp., 1984.

Atmospheric Trace Constituents, F. Herbert (Ed.), Heyden, Philadelphia, Pa., 152 pp., 1982, $16.

Bibliography of Alluvial-Fan Deposits, T. H. Nilsen and T. E. Moore, Geo Books, Norwich, Eng., vii + 96 pp., 1984.

Catastrophes and Earth History: The New Uniformitarianism, W. A. Berggren and J. A. van Couvering (Eds.), Princeton Univ., Princeton, N. J., xii + 464 pp., 1984, $65.

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Erosion and Sediment Yield: Some Methods of Measurement and Modelling, R. F. Hadley and D. E. Walling (Eds.), Univ. Press, Cambridge, Eng., 224 pp., 1984, $18.

The Expected Impact of the Electronic Chart on the Canadian Hydrographic Service, A. G. Hamilton, B. G. Nickerson and S. E. Masry (Eds.), *Tech. Rpt. No. 106*, Univ. of New Brunswick, Fredericton, New Brunswick, 1984, x + 111 pp., 1984.

Eutrophication and Land Use: Lake Dillon, Colorado, W. M. Lewis, Jr., J. F. Saunders, III, D. W. Crumpacker, Sr., and C. M. Brendecke (Eds.), *Ecol. Stud.*, vol. 46, Springer-Verlag, N. Y., x + 202 pp., 1984, $39.80.

Geomagnetism of Baked Clays and Recent Sediments, K. M. Creer, P. Tucholka and C. E. Barton (Eds.), Elsevier, N. Y., xx + 324 pp., 1983, $53.25.

Geothermics: An Introduction, A. Buntebarth, Springer-Verlag, N. Y., ix + 144 pp., 1984, $22.50.

Groundwater as a Geomorphic Agent, R. G. LaFleur (Ed.), Allen & Unwin, Boston, Mass., xvi + 390 pp., 1984, $50.

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Renewable Resources Management: Applications of Remote Sensing, Amer. Soc. of Photogramm., Falls Church, Va., x + 774 pp., 1984, $40.

Reversals of the Earth's Magnetic Field, J. A. Jacobs, Heyden and Son, Philadelphia, Pa., 229 pp., 1984, $35.

The Role of Hydrology in the United Nations Water Decade, W. Schaap (Ed.), TNO, The Hague, 172 pp., 1983.

Roles and Responsibilities in Geoscience Information, U. H. Rowell (Ed.), *Geoscience Information Society Proceedings*, vol. 14, Geosci. Inform. Soc., Alexandria, Va., 1983, $20.

Saving Water in a Desert City, W. E. Martin, H. M. Ingram, N. K. Laney and A. H. Griffin, Resources for the Future, Wash., D.C., xiii + 111 pp., 1984, $10.

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Vegetation in Civil and Landscape Engineering, D. H. Bache and I. A. MacAskill, Sheridan House, Dobbs Ferry, N. Y., xv + 315 pp., 1984, $450.

Volcanoes of the Earth: Second Revised Edition, F. M. Bullard, Univ. of Texas, Austin, 629 pp., 1984, $35.

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Cosmochemistry Faculty Position/University of Arizona. The Department of Planetary Sciences and the Lunar and Planetary Laboratory invite applications in a continued search to fill a state-funded, tenure track position in cosmochemistry. The area of specialization within Cosmochemistry is open. The appointment involves research, teaching, and the supervision of graduate students. The successful candidate will be either at a junior level with extraordinary promise of scientific accomplishment, as well as the potential for developing substantial leadership capabilities and an international scientific reputation, or will be at a senior level having already demonstrated these qualities. Applications, including a resume and the names and addresses of four individuals who could serve as professional references, should be sent, by December 31, 1984, to Professor Eugene H. Levy, Head, Department of Planetary Sciences, University of Arizona, Tucson, AZ 85721.

The University is an equal opportunity/affirmative action employer.

University of Wisconsin—Madison. The Department of Geology and Geophysics invites applications for an anticipated tenure track position at the assistant professor level in applied geomorphology and/or hydrogeology commencing in August 1985. The applicant should be committed to developing a strong research program as well as teaching undergraduate courses in some aspects of engineering and environmental geology. The Ph.D. is required. Applicants with course work in engineering and an interest in the field application of geologic principles are especially encouraged to apply. Send letter of application outlining your professional goals, transcripts, resume, copies of publications, and three letters of reference to Dr. Mary P. Anderson, Department of Geology and Geophysics, Weeks Hall, University of Wisconsin, Madison, WI 53706. Closing date is January 1, 1985.

The University of Wisconsin is an equal opportunity/affirmative action employer.

William M. Rice University/Marine Geophysics. The Department of Geology invites nominations and applications for the W. Maurice Ewing Chair in Oceanography. We are seeking applicants for a new position in marine geophysics to fill this chair.

The Department of Geology has recently added two reflection seismologists to its faculty and is building a state-of-the-art seismic processing facility. The successful applicant will be expected to teach graduate and undergraduate courses and to develop a strong research program in his or her area of interest. Cooperation in ongoing research with other members of the Rice faculty and faculty at other Texas universities would be encouraged.

Send enquiries and applications to Dr. Albert Bally, Chairman, Department of Geology, Rice University, Houston, Texas, 77251-1892. Applications should include a detailed resume, the names and addresses of three references, and a statement of research interest.

Rice University is an equal opportunity/affirmative action employer.

Position Available/University of Hawaii. Postdoctoral Fellowship, full time, salary $22,000—$24,000. One-year appointment, to begin approximately January 1, 1985, with second year contingent on availability of funds.

A researcher with a background in meteorology or atmospheric physics is needed to join an ongoing study of local atmospheric properties at Mauna Kea Observatory, one of the world's most renowned sites for ground-based astronomy. We aim to (1) characterize the local microclimate at the mountain top, and (2) study clear air turbulence above the site. Highly advanced state-of-the-art meteorological instrumentation, now in place at the site, will be used as a basis for the study.

The candidate will be required to spend some time on Mauna Kea, although most work will be done in Honolulu at the Institute for Astronomy (IFA), one of the forefront centers for research in astronomy. The IFA is part of the University of Hawaii and close to the UH Department of Meteorology. Collaboration with the Department of Meteorlogy will be encouraged.

We seek a candidate with knowledge of physical meteorology and/or upper atmospheric physics. A basic background in synoptic meteorology is required, and familiarity with measurement systems is desirable. Minimum Qualifications: Ph.D. in Meteorology, Atmospheric Physics, or a related field; a proven record as a researcher as demonstrated by publications (or equivalent experience); and recommendations by peers.

Applications should be sent to: Dr. Don Hall, Director, Institute for Astronomy, 2680 Woodlawn Drive, Honolulu, Hawaii 96822, so as to arrive by November 30, 1984. Further inquiries can be directed to Dr. Laird Thompson, phone 808-948-8102.

The University of Hawaii is an equal opportunity/affirmative action employer.

Hydrogeologist or Hydrologist. The Kansas Geological Survey, a division of The University of Kansas, solicits applications for a hydrogeologist or hydrologist. Permanent, full-time position subject to annual review. Salary Range: $20,000—$30,00 per year, depending on qualifications. Required qualifications: Master's degree in hydrogeology or hydrology. Ability to develop, conduct, and participate in hydrogeologic and hydrologic studies, evaluating ground-water resources in Kansas, including field work as needed. Ph.D. in hydrogeology or hydrology and/or publication records or proven experience preferred.

Freedom to conduct research within the framework of the KGS Geohydrology Section's programs and support of a university environment. Opportunity for graduate study or teaching; and fully funded research opportunities in excellent research facilities.

Contact Personnel Manager, Kansas Geological Survey, 1930 Constant Avenue, Campus West, The University of Kansas, Lawrence, Kansas 66044 (Ph. 913-864-3965) for full position description, or to apply, send resume, college transcripts and list of published research. Applications received on or before December 28, 1984 will be considered.

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Research Associate/University of Maryland. The Space Physics Group of the Department of Physics and Astronomy has an opening for a Research Associate for an initial one-year period with high likelihood of extension. The position involves research on energetic particles of solar and interplanetary origin. Applicants should possess a Ph.D. in a relevant area of physics or astrophysics; relevant research experience is highly desirable. Inquiries and applications should be addressed to Prof. Glenn M. Mason, Department of Physics and Astronomy, University of Maryland, College Park, MD 20742. Applicants should send a vita including complete bibliography and a description of research experience, and should arrange for the sending of at least three letters of reference.

The University of Maryland is an equal opportunity/affirmative action employer.

Manager, Research Computer Facility. The University of Oklahoma is looking for a person to manage a recently purchased VAX 11/785 computing facility dedicated to research in the Geosciences. Hardware and Software are designed for image processing, seismic reflection data processing, and graphical display of geological, geographical and geophysical data.

In addition to the 11/785 with 8mb of CPU memory, the system includes an array processor, five tape drives, five disk drives, a line printer, a 36" electrostatic plotter, and two high resolution graphics work stations with a digitizing board. The image processing hardware includes a Gould-DeAnza IP8500 processor with 16 image memory planes, real time disk memory and three high resolution color monitors.

The person selected must have at least a BS degree in science, math, engineering or related field; two years programming experience including FORTRAN; educational or computing experience in solid earth geophysics or meteorology. Experience with the VAX VMS operating system as well as supervisory experience are desired.

Salary is negotiable. People interested in the position should send a resume, copies of academic transcripts, and the names, addresses and telephone numbers of three references to:

John Wickham, Director
School of Geology & Geophysics
University of Oklahoma
Norman, OK 73019

Applications must be received by November 2, 1984.

High Altitude Observatory Scientific Visitor Program/NCAR. Scientific visitor appointments at the High Altitude Observatory are available for new and established Ph.D's for up to one year to carry out research in solar physics, solar-terrestrial physics, and related subjects. Applicants should provide a curriculum vitae, including education, work experience, publications, the names of three scientists familiar with their work, and a statement of their research plans. Applications must be received by 15 January 1985 and they should be sent to: The HAO Visitor Committee, High Altitude Observatory, National Center Atmospheric Research, P.O. Box 3000, Boulder, Colorado 80307-3000.

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Signal Processing and Control Systems Scientific Engineering Positions. Available at B.S., M.S. and Ph.D. level in the following R&D areas: Digital Signal Processing—design and analyze algorithms, conduct data analysis with emphasis on detection, estimation and spectrum analysis. Control Systems Engineering—design and analyze digital/analog adaptive control. A working familiarity with FORTRAN is required. Working closely with other highly skilled professionals, individuals will participate in an environment that nurtures self-directed achievement. U.S. citizenship is required; current DOD security clearances desired. Submit resume to Personnel Department, XYBION CORPORATION, 240 Cedar Knolls Road, Cedar Knolls, New Jersey 07927.

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The Remote Sensing Branch of the Naval Ocean Research and Development Activity (NORDA) located at National Space Technology Laboratories, Bay St. Louis, MS. is seeking qualified applicants for a physical oceanographer with experience and interest in research studies of ocean dynamics via satellite altimetry. Duties will include providing oceanographic interpretation of the GEOSTAT mesoscale product; aid in obtaining subject procedures for the production of mesoscale analysis; assist in the GEOSTAT Ocean Application Program (GOAP) through the coordination of ongoing objective and subjective data system development and interfacing with programmers to provide oceanographic guidance for software implementation; develop methods for the production of Expanded Ocean Thermal Structure (EOTS) bogus files from altimeter derived topography; responsible for reporting results through published technical reports, journal papers and technical briefings. Applicants must have, as a minimum, a bachelor's degree in oceanography or related disciplines, and a minimum of three years of professional experience or graduate education, or a combination of both. **Qualified applicants should contact the Naval Ocean Research and Development Activity, NSTL, MS, 39529. ATTN: Code 140 or call (601) 688-4640 for application forms.**

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Faculty Position in Structural Geology/Tectonics. The Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, has a tenure track opening at the Assistant or Associate Professor level in the area of structural geology/tectonics. The position will be filled for the beginning of the Fall 1985 term. The department currently has 31 full-time faculty, including 12 geologists and geophysicists.

The successful applicant will be expected to have completed the PhD degree. Courses to be taught include undergraduate structural geology as well as courses in structural analysis, tectonics, or other areas of research activity. He or she additionally will be expected to develop a vigorous program of sponsored research and to direct graduate student research projects at the MS and PhD level.

Please send complete resume and the names of at least three references to V.V. Cavaroc, Search Committee Chairman, Department of MEAS, North Carolina State University, Raleigh, NC 27695–8208; phone (919) 737-2212. Applications will be considered as received, with a closing date of January 15, 1985.

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Research Investigator or Assistant Research Scientist. Research investigator or assistant research scientist needed to carry out research involving observational and theoretical studies of the dynamics of the thermosphere and ionosphere. Observational work will use ground based optical and radar instrumentation for observation of the upper atmosphere. Theoretical work will involve computer programming, numerical analysis, and data processing. Frequent travel to observational sites and scientific meetings. Candidate must write scientific papers, lecture at scientific meetings, and prepare proposals for research support.

A Ph.D. in atmospheric science is required, or in lieu of the Ph.D., at least five years of research experience in optical and radar observations of the upper atmosphere, as well as at least ten scientific papers published in refereed scientific journals. The position involves 40 hours per week. Basic annual salary will be $32,000. Applicants should send resumes to 2510 Woodward Avenue, Room 415, Detroit, Michigan 48202. Reference No. 31884.

Employer paid ad.

Structural Geology and Tectonics. The Department of Geosciences at the University of Arizona is pleased to announce a new position in the general area of structural geology and tectonics. We seek a creative scientist with an interest in the structure and evolution of the earth's crust, someone who can bring new approaches to crucial problems in the evolution of orogenic systems combined with more traditional and modern methods. Candidates should expect to teach undergraduate structural geology, develop new graduate course material to complement and extend existing programs, advise graduate research, and carry out an active research program in their area of special interest. The academic level and salary will be dependent upon the experience and qualifications of the successful candidate. The position will be available Fall, 1985.

APPLICATION DEADLINE: November 1, 1984. Applicants should send curriculum vita, bibliography, statement of research interests, and the names of four professional references to: George H. Davis, Department Head, Department of Geosciences, The University of Arizona, Tucson, AZ 85721.

The University of Arizona is an equal opportunity/affirmative action employer.

Applied Geophysics/Bowling Green State University. The Department of Geology invites applications for a tenure track, assistant professor position in applied geophysics. Salary up to $30,000; Ph.D. required. The successful candidate will be expected to develop a research program in some aspect of applied geophysics and teach courses in geophysics, exploration geophysics, and in his or her specialty. The Department has 11 full-time faculty. In addition, two faculty from the Physics Department participate in our geophysics program. Complete geophysical instrumentation, including a seismograph station and rock mechanics lab, are available.

Interested persons should send resume, statement of research interests, official transcripts, and three letters of reference to Charles M. Onasch, Chairman, Search Committee, Department of Geology, Bowling Green State University, Bowling Green, Ohio 43403. The closing date is November 30, 1984. We will be interviewing at GSA in Reno.

BGSU is an equal opportunity/affirmative action employer.

Department of Geosciences/University of Houston. The Department of Geosciences has permission to hire at least one geophysicist to complement the 16 members of our faculty (3 in Geophysics). This is a tenure track position with a starting date of August, 1985. We are particularly interested in talking with individuals with strong backgrounds in theoretical and experimental seismology. Salary and rank will be determined on an individual basis. Applicants should submit: (1) a curriculum vita; (2) a brief statement outlining research interests; (3) a brief statement outlining teaching interests; (4) three letters of recommendation; (5) a copy of graduate transcripts.

John C. Butler
Geosciences
University of Houston, University Park
Houston, Texas 77004.

Several of my colleagues and I will be at the GSA meetings in Reno and would like to talk with potential applicants.

The University of Houston is an equal opportunity/affirmative action employer.

Dean of Oceanography
Oregon State University

Oregon State University invites nominations/applications for Dean, College of Oceanography. The dean provides leadership to a graduate college of oceanography with 93 faculty, 80 students, and excellent research facilities in Corvallis and Newport. Salary dependent upon qualifications. Tenured, full-time appointment. Completed applications for the position should be received by December 31, 1984. Oregon State University is an AA/EO employer and encourages applications from females and minorities. Address: Dr. John S. Allen, Chairperson, Dean Search Committee, College of Oceanography, Oregon State University, Corvallis, OR 97331.

Physical Oceanographers. The Physical Oceanography Branch of the U.S. Naval Oceanographic Office seeks full-time Oceanographers for the study of the effects of oceanic current and thermal/density structure on undersea systems using data collected from various platforms for a variety of projects. The projects involve the collection, analysis and reporting of physical oceanographic data directly applicable to relevant Navy environmental requirements. Up to 50% field duty may be required.

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Please contact (for required forms): Debra Staples, #N00–72(84), Commercial 601-688-5720, Autovon 485-5720, or FTS 494-5720, U.S. Naval Oceanographic Office, Management & Personnel Division, Personnel Operations Branch, Code 4320, Bay St. Louis, NSTL, Mississippi 39522.

Director of Laboratories/Building Manager. Position requires background in university research programs. PhD or MS in science or engineering preferred. Successful candidate will oversee maintenance and operation of a four-story lab/office building; manage departmental accounts; oversee technical support groups. Salary $27–37K. Send resume and have three letters of reference sent to: Dr. G.N. Hanson, Chairman, Department of Earth & Space Sciences, SUNY Stony Brook, Stony Brook, NY 11794–2100.

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University of Utah Structural Geology/Tectonics/Tectonophysics. The Department of Geology and Geophysics at the University of Utah seeks applications for a tenure track position in structural geology, tectonics or tectonophysics. It is anticipated that this position will be filled at the assistant professor level, but applications by more senior persons will be considered. The position requires a Ph.D. with emphasis in structural geology, regional tectonics or tectonophysics. The new faculty member will have the opportunity to teach in the area of his or her specialty and may also be assigned introductory level courses. The successful candidate will be expected to establish a vigorous research program involving graduate students. The person who fills this position will join an active program in structural geology and tectonics that includes both field projects and integrated geology/geophysics and mechanics/fluid chemistry studies of structures in the western Cordillera. There is an excellent opportunity to collaborate with other faculty in structural geology, sedimentology, geophysics, geochemistry and petrology. A vita, copies of publications, names of three persons that may provide references, and a letter outlining the candidate's research and teaching interests should be sent to Dr. William P. Nash, Chairman, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112–1183. Deadline for receipt of applications is December 31, 1984 with the appointment starting in September 1985.

The University of Utah is an equal opportunity/affirmative action employer.

Soil Physics/Ag Engineering. Asst./Assoc. professor for full time, tenure track, teaching and research position at the University of Arizona. Research responsibilities relate to the use of experimental techniques, instrumentation, microcomputer interfacing, and data management and analysis in soil and water. Teaching responsibilities include microcomputer interfacing and measurement techniques in soil and water. Ph.D. in agricultural engineering, soil physics or related field with background in instrumentation, microcomputer interfacing and soil and water engineering or physics. Send resume, transcripts, list of publications and names of three to five references to H.L. Bohn, Search Committee Chairman, Dept. of Soils, Water and Engineering, Univ. of Arizona, Tucson, AZ 85721. Position open until January 15, 1985 or until a suitable candidate is identified.

An Equal Opportunity/Affirmative Action employer.

Saint Louis University. The Department of Earth and Atmospheric Sciences invites applications for a tenure-track assistant professor position in geophysics effective for the fall of 1985. We seek an individual with broad interests who will complement active research programs in seismology and earth structure. Preference will be given to candidates who can teach existing courses in plate tectonics, geomagnetism and/or geoelectricity. The successful candidate must have a Ph.D. degree and will be expected to maintain an active research program, to teach geophysics courses at the undergraduate and graduate levels, and to supervise graduate student research. The application deadline is January 15, 1985. Applicants should send a curriculum vitae, a statement of research and teaching interest and the names of 4 professional references to:

Dr. Brian J. Mitchell, Chairman
Department of Earth and Atmospheric Sciences
Saint Louis University
PO Box 8099—Laclede Station
St. Louis, MO 63156.

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University of Wyoming/Department of Geology and Geophysics. The Department of Geology and Geophysics encourages applications from students interested in pursuing graduate research in the fields of igneous and metamorphic petrology and geochemistry. Current research topics, involving field and laboratory studies, include: island arc and continental volcanics, petrogenesis of granitic and anorthositic rocks, evolution of the Archean crust, petrogenesis of ophiolitic rocks, and geothermometry and geobarometry as applied to the evolution of orogenic terranes. Facilities include: an analytical geochemical lab for whole-rock and trace element analysis, a fully automated CAMECA microprobe, two JOEL scanning electron microscopes, a thermal ionization mass spectrometer for analyzing Rb-Sr, Sm-Nd, and U-Th-Pb isotopes, a microthermometry lab, and an experimental petrology lab. Applicants should contact:

Petrology/Geochemistry Program
Department of Geology and Geophysics
PO Box 3006, University Station
University of Wyoming
Laramie, WY 82071.

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Please send your resume with salary history and references to:

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EOE/M/F.

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Applications are invited for a chair of applied mathematics in the Department of Mathematics. The post is tenable from 1 October 1985. Preference will be given to candidates with a proven research record in applied mathematics and with a wish to interact with colleagues working in the areas of fluid dynamics, geophysical fluid dynamics, geomagnetism and numerical analysis.

Salary on the agreed professorial range, current minimum #17,275 P.A. (under review).

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Closing date for receipt of applications 22 November 1984.

Yale University/Solid Earth Geophysics. The Department of Geology and Geophysics is soliciting applications for a junior faculty position in solid-earth geophysics to begin in the academic year 1985–1986. Areas of interest to the department include seismology, exploration geophysics, mechanical and physical properties of rocks and minerals, geomagnetism, tectonophysics, and geodesy. Curriculum vitae, publications and the names of three or more referees should be sent by December 1, 1984 to Karl K. Turekian, Chairman, Department of Geology and Geophysics, Yale University, Box 6666, New Haven, CT 06511.

Yale University is an equal opportunity/affirmative action employer and encourages applications from all qualified scientists.

Postdoctoral Position/Naval Postgraduate School. The Ocean Turbulence Laboratory has available a postdoctoral position for a person interested in the analysis and interpretation of oceanic turbulence data. The tenure is for one or two years. The successful candidate should have a Ph.D. in physical oceanography and although experience with turbulence data is preferable it is not essential. The opportunity for involvement in data gathering expeditions is also available. Resumes can be sent to Dr. R.G. Lueck, Code 68 Ly, Naval Postgraduate School, Monterey, CA 93943.

AA/EOE.

Graduate Assistantships in Physics, Space Physics and Atmospheric Sciences. Assistantships are available for graduate students seeking M.S. and Ph.D. degrees in Space Physics, Atmospheric Sciences or Physics, at the University of Alaska. Research areas include both Experimental and Theoretical studies in Space Plasma Physics, Solar Physics, Computational Physics, Radio Physics, Atomic and Molecular Spectroscopy, Atmospheric Optics, Atmospheric Dynamics, Atmospheric Chemistry, Physical Meteorology and Glaciology. Thesis research is conducted through the Geophysical Institute. The stipend is $12,000 to $15,000 per year depending on credentials. Students with B.S. degrees in Physics, Atmospheric Sciences, Electrical or Mechanical Engineering are encouraged to apply. For more information, write to Professor J.R. Kan, Head, Department of Space Physics and Atmospheric Sciences, or Professor G. Shaw, Head, Department of Physics, University of Alaska, Fairbanks, Alaska 99701 or call 907-474-7513.

Solid Earth Geophysicist. Faculty position at the Graduate Department of Scripps Institution of Oceanography and the Institute of Geophysics and Planetary Physics. Applications are invited for a tenure track faculty position in the field of solid Earth geophysics, including its theoretical and observational aspects. The position will involve graduate level teaching and the supervision of graduate student research. Qualifications include a Ph.D. in one of the sciences and demonstrated excellence and independence in research. Weight will be given to evidence of superior teaching ability. An appointment at the Assistant Professor level is envisaged but qualified applicants at all levels will be considered. Associate or professorial level candidates must demonstrate a strong research record in their specialty; assistant level candidates will be expected to show evidence of their potential by means of a publication record appropriate for their experience and in their letters of recommendation. Salary commensurate with qualifications and experience. Send letter of application, curriculum vitae, including research interests, and the names of three references to: Chairman, Graduate Department A-008, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093. Responses must be received by November 30, 1984.

An equal opportunity/affirmative action employer.

Ph.D. Scientist/High Altitude Observatory, National Center for Atmospheric Research. Conducts both independent and collaborative research aimed at understanding a broad variety of solar and related astrophysical phenomena, especially those involving the dynamical behavior of magnetized plasmas. Develops analytical and numerical techniques for the description of macroscopic and microscopic plasma properties and applies these techniques to studies involving theoretical modeling and observational interpretation of the solar interior, solar atmosphere, interplanetary medium, and related astrophysical systems. Should have research experience in theoretical studies of magnetized plasmas. Position available: 9/1/85. Salary: $27,104–$40,656/year. Scientist I appointments are for terms up to three years; individuals may be appointed to the next higher level in accordance with UCAR scientific policy. Applications should be sent to: R. M. MacQueen, HAO, NCAR, PO Box 3000, Boulder, CO 80307–3000.

NCAR is an equal opportunity/affirmative action employer.

Civil Engineering. The University of Notre Dame is seeking applications for a tenure track Assistant or Associate Professor position in its Department of Civil Engineering. Applicants should have an earned Ph.D. in Civil Engineering or an appropriately allied discipline; the initiative, scholarship, and creativity to direct a funded research program encompassing M.S. and Ph.D. students; and a demonstrated ability for quality teaching at the graduate and undergraduate levels. The successful candidate will strengthen the Department in at least one of the following areas: water quality, hydrology, environmental chemistry, soil mechanics, geotechnical engineering, design of structural analysis. Appointment will begin with the Fall 1985 semester or other agreed upon date. Send resume and names of three references to: William G. Gray, Chairman, Department of Civil Engineering, University of Notre Dame, Notre Dame, IN 46556.

Affirmative Action/Equal Opportunity Employer.

Department of Geology/Indiana University. The Department of Geology at Indiana University is seeking persons skilled in the application of physics to the solution of geologic problems. Special consideration will be given to applicants with demonstrated expertise and potential for outstanding research in one of the following areas:

(a) Solid Earth Geophysics—exploration geophysics, rock mechanics or seismology.

(b) Mineral Physics—with special interests in the implications of changing mineral properties on geologic processes.

(c) Hydrodynamics—groundwater mechanics and the dynamics of sedimentary processes.

Indiana University has aggressive programs of research and teaching related to the above areas which it wishes to significantly expand. Successful applicants will be expected to assist in the expansion of these programs through interaction with current faculty as well as through development of new programs of interdisciplinary research.

We expect that appointments will be made at the assistant professor level; however senior scientists with superior records of success in publication and attraction of research funding also will be considered for a higher level. One appointment will be made for the 1984–85 academic year. We anticipate making two more appointments in successive years.

We will be interviewing at the Geological Society of America meeting in Reno, Nevada, November 5–8, 1984 and the American Geophysical Union Fall Meeting in San Francisco, California, December 3–7, 1984.

Inquiries and formal letters of application, including resume, should be sent to:

N. Gary Lane
Chairman
Department of Geology
Indiana University
Bloomington, IN 47405.

Indiana University is an affirmative action/equal opportunity employer.

College of Geosciences/University of Oklahoma. Applications and nominations are invited for the position of Director of the School of Geology and Geophysics. The Director is expected to have a Ph.D. or equivalent, a strong, ongoing research program and administrative experience; industrial experience helpful; field of geological specialization open; to begin July 1, 1985; salary to be negotiated.

In 1986, the School will move into the new 300,000 sq. ft. Energy Center along with other elements of the College of Geosciences: the Oklahoma Geology Survey; and the School of Petroleum and Geological Engineering and the School of Chemical Engineering and Materials Sciences, both from the College of Engineering.

Applications with curriculum vitae, names and addresses of three references, and/or nominations should be sent to:

Francis G. Stehli, Dean
College of Geosciences
University of Oklahoma
601 Elm Street, Room 438C
Norman, OK 73019.

Consideration of applications will begin January 1, 1985.

The University of Oklahoma is an Equal Opportunity/Affirmative Action Employer.

Geochemistry. The University of California, Davis will fill a permanent, tenure track, faculty position at the assistant professor level beginning Fall, 1985. Candidates having interests in isotope geochemistry and/or the geochemistry of economic deposits are especially encouraged to apply but other specialties in geochemistry will be considered. A PhD degree is required. Responsibilities include teaching at the undergraduate and graduate levels, and research in geochemistry.

Applicants should submit complete vita, a statement of research and teaching interests and the names of three referees. Deadline for application is January 15, 1985. Inquiries and applications should be directed to: Dr Howard W. Day, Department of Geology, University of California, Davis, CA 95616.

The University of California is an equal opportunity/affirmative action employer.

Director: Atmospheric Sciences Research Center/State University of New York at Albany. The State University of New York at Albany invites nominations and applications for the position of Director of the Atmospheric Sciences Research Center. The main purposes of the university-wide center, located adjacent to the main campus of the State University of New York at Albany are, a) to promote and encourage programs of research in basic and applied sciences, especially as these relate to our environment and b) to encourage the fullest possible participation in these research activities by faculty and students throughout the university and in all appropriate industrial, governmental and educational groups.

Qualifications: Scientists of international reputation having a record of publications relating to atmospheric problems; involvement with research in own field and interest in research being conducted by colleagues; proven ability in administrative skills; desire and aptitude to communicate about science with students and the general public; success in securing funding for research from governmental, industrial, and other agencies.

Inquiries, nominations, or applications with supporting resumes should be directed to John Shumaker, Vice President for Research and Educational Development, State University of New York at Albany, Albany, NY 12222. Application deadline: November 16, 1984.

SUNYA is an Affirmative Action/Equal Opportunity employer.

Applications from minority persons, women, handicapped persons and Viet Nam era veterans are especially welcome.

Hydrogeologists/Illinois State Geological Survey. Positions are available for research staff to study problems inolving hazardous and radioactive waste disposal and groundwater resource evaluation. Applicants should possess an advanced degree in hydrogeology or related field and have strong communication skills. Send a letter of application, resume, list of three references and list of publications to: Marilyn Rebecca, Personnel Office, Illinois State Geological Survey, 615 E. Peabody Drive, Champaign, IL 61820 by October 31, 1984.

The Illinois State Geological Survey is an equal opportunity/affirmative action employer.

Sedimentologist-Oceanographer/Texas A&M University. Applications are invited for a tenure track faculty position in the general field of marine sedimentology. The position will involve graduate level teaching and supervision of graduate student research. The successful applicant will have demonstrated excellence in or a strong potential for independent research in the field of marine sedimentation. The position is available beginning September 1, 1985. Salary and rank will be commensurate with experience and qualifications. Applicants are invited to submit curricula vita, copies of publications, names of three persons who may serve as references, and a letter outlining the applicant's teaching and research interests by December 31, 1984, to Robert O. Reid, Distinguished Professor and Head, Department of Oceanography, Texas A&M University, College Station, Texas 77843.

Texas A&M University is an affirmative action/equal opportunity employer.

Post Doctoral Fellow in Geophysical Fluid Dynamics (G.F.D.)/University of Southern California. To organize and perform experiments, analyze data and present the results in oral and written form for the problem of flow over topography in rotating-stratified fluid systems. Ph.D. in suitable Engineering or scientific discipline required. Knowledge of micro-processor based data acquisition systems essential. Position available immediately for a two-year period. Salary commensurate with experience. A complete resume and at least three letters of recommendation should be sent to Prof. T. Maxworthy, OHE 430, Department of Mechanical Engineering, University of Southern California, Los Angeles, CA 90089–1453.

EOE/MFH.

Montana Bureau of Mines & Geology/Montana Tech. Applications are invited for a non-tenure track academic research appointment in hydrogeology to be filled at the research instructor or research assistant professor level.

This position will have broad research responsibilities in one or more of the following areas: regional and site-specific hydrogeological studies, hydrogeologic and hydrochemical aspects of surface coal mining and reclamation, and assessment of aquifer characteristics by aquifer testing and hydrochemical evaluations. The position entails considerable field work and will be located in Billings, Montana.

Candidates must have a Master's degree (Ph.D. preferred) in Hydrogeology or a related science and at least three years of hydrogeological experience, with emphasis on analysis and quantitative aspects of hyrogeology.

The closing date for applications is November 12, 1984. Salary will be $26,000—$33,000/year depending upon education and experience.

Applications with resume and names and phone numbers of three references should be sent to: Director, Montana Bureau of Mines and Geology, Montana College of Mineral Science and Technology, Butte, MT 59701.

An EEO/AA Employer.

University of Michigan/Isotope Geochemist/Geochronologist. The Department of Geological Sciences invites applications for a tenure track or tenured position (assistant, associate, or full professor), pending budgetary approval, to begin September 1, 1985, or later. We are looking for an outstanding researcher in radiogenic isotope geochemistry with broad interests, including the history and evolution of the continental crust. We are willing to consider expertise in a range of isotopes, but have preference for modern Argon techniques, and will provide funds to establish a modern laboratory. Teaching responsibilities will include a course in geochemistry, plus other courses selected from introductory, field, and graduate offerings according to the candidate's interests. Applicants should send a resume, names of five persons from whom the Department may request letters of recommendation, and a brief statement of research interests to: Professor Stephen E. Kesler, Search Committee Chairman, Department of Geological Sciences, 1006 C.C. Little Building, Ann Arbor, MI 48109–1063. The search will close January 20, 1985, but later applications may be considered.

The University of Michigan is a non-discriminatory, affirmative action employer.

Professor (Research)/Stanford University/Plasma Physics, EM Waves, Space Physics. We are seeking a senior person who has demonstrated scientific, managerial, and leadership qualifications in one or more of the following disciplines: Space Plasma Physics, electromagnetic waves, and solar-terrestrial physics. We expect the successful candidate to have established an outstanding reputation documentable through professional writings or other evidence of personal technical creativity, letters of reference from recognized research leaders in the disciplines mentioned above, and/or awards and other recognition from appropriate professional societies.

It is expected that this individual will develop a research program in one of the disciplines given above working in coordination with ongoing programs within the STAR Laboratory and, possibly, with other activities within the Stanford Center for Space Science and Astrophysics. It is expected that this individual will have a strong background in experimental techniques, either in the laboratory or in the field, including the environment of space; experimental activities in either laboratory or space plasma physics would be regarded as good qualifications. However, close association with theoretical developments in plasma physics and/or electromagnetic theory will clearly be desired. It is also expected that the individual will have a demonstrated capability for securing federal or other research grant support, or be deemed by the selection committee of being capable of securing such funds.

It is anticipated that the person chosen will devote the major part of his or her time to research activities. However, there is an opportunity for participation in academic responsibilities of the Electrical Engineering Department, including, when time permits, teaching graduate and undergraduate classes, serving on various committees of the department, School of Engineering, and the university. It is expected that the person chosen will participate actively in the training of graduate students.

The Chairman of the selection committee for this position is *Professor Robert A. Helliwell, Professor of Electrical Engineering, Space, Telecommunications, and Radioscience Laboratory, Stanford University, Stanford, California 94305.* Other members of the selection committee include Professor P.M. Banks, Professor R.N. Bracewell, Professor L.R.O. Storey, and Professor L. Tyler.

Application deadline is November 15, 1984.

Mathematician (Numerical Analyst)/USDA, Agricultural Research Service. The USDA-ARS, Hydro-Ecosystem Research Unit, Fort Collins, Colorado, has an immediate opening for a Numerical Analyst (GS-1520–12). The Hydro-Ecosystem Research Unit is an interdisciplinary group with scientific and technological research activities in applied soil physics, surface hydrology, groundwater hydraulics, alluvial-stream mechanics, and water and wind-born migration and dispersion of agricultural pollutants. The major objectives of this Unit include the development and evaluation of large-scale computational models of agricultural ecosystem processes. The site offers excellent working and computer facilities, with ready access to first-rate technical libraries and laboratories, and high-powered scientific computer systems at nearby Colorado State University campus.

The incumbent will provide theoretical, computational and software-design support for the development of large scale computational models. Preferably candidates should have an advanced graduate degree in mathematics, physics, engineering, or an equivalent combination of education/professional experience. The following selective factors will distinguish qualified candidates from those not qualified: Knowledge of FORTRAN language programming and in the application of advanced numerical techniques, including finite difference and finite element methods, to the solution of multi-dimensional boundary-value problems. Knowledge of fluid dynamics and turbulent transport concepts is desirable. Some of the models will be implemented on Cyber-205 computer, so knowledge of vector processing machines is desirable. Skill in written communication for the preparation of technical reports and model documentation is desirable.

This is a permanent Federal Civil Service position. Applicants must be U.S. citizens. Interested persons should send a completed Standard Form 171, College Transcript or a List of College Courses using OPM Form 1170/17, and supporting documents such as names, addresses, and telephone numbers of at least three professional references to the person and address listed below. The above is a summary of the qualifications; applicants may call for further information, application procedures, and necessary forms, or write to:

Cathleen Enuton
USDA, Agricultural Research Service
BARC-West, Building 003, Room 107
Beltsville, MD 20705
Telephone: A/C 301-344-3138.
An Equal Opportunity Employer.

Faculty Positions in Geochemistry and in Neotectonics. The State University of New York at Binghamton invites applications for tenure track positions in these two areas beginning August, 1985. The appointments will be at the assistant or junior associate professor level and will require completion of the PhD prior to this date. The candidates must demonstrate potential to develop a productive research program as well as teach at the undergraduate and graduate levels.

The geochemist should have primary interests in some aspect of low temperature geochemistry. The neotectonist should have some interest and experience in study of sedimentologic and/or geomorphic processes and products as well as tectonic ones. Applicants should send a resume and names of three persons who can be contacted for references to: J.R. Beerbower, Department of Geological Sciences and Environmental Studies, State University of New York, Binghamton, NY 13901.

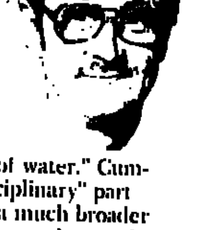
The State University of New York is an affirmative action/equal opportunity employer. The closing date for this position is 15 December 1984.

POSITIONS WANTED

Geologist/Geochemist. 33, M.A., Ph.D. 1983. Specializing in low temperature geochemistry and geochronology with extensive experience in Rb-Sr mass spectrometry. Several publications. Seeks industry, academic research, or government position. Box 027, American Geophysical Union, 2000 Florida Avenue N.W., Washington, DC 20009.

AGU

WRR Editor Ronald Cummings



It has been nearly a year since Ronald Cummings took over as policy sciences editor of *Water Resources Research* (WRR), and in that time he has worked to make the journal live up to its role as "an interdisciplinary journal integrating research in the social and natural sciences of water." Cummings takes the "interdisciplinary" part seriously. "I'd like to see a much broader range of policy issues presented to readers," he says. "I would hope it would then stimulate interchange between our colleagues concerning evolving issues of the '80's and '90's."

Cummings brings a solid background as a resource economist to his 4-year term as editor, which began last January and runs until December 1987. Cummings succeeds Jared Cohon as policy sciences editor. Stephen J. Burges is the WRR editor for hydrological, physical, chemical, and biological sciences. Now a Professor of Economics and Director of the Program in Natural Resources Economics at the University of New Mexico, Cummings is a past president of the Association of Environmental and Resource Economists. He has been a consultant in matters of water resources management, forestry management, and energy policy for more than a decade, working on projects in both the United States and Latin America. Since joining the faculty at New Mexico in 1975, he has, among other things, worked with engineers at the Los Alamos National Laboratory in developing operation/management models for hot, dry rock geothermal systems.

More recently, his work has concentrated on collaborative research with legal scholars that focuses on issues related to federal reserved rights to water and interstate competition for water that has resulted from recent court cases. These cases, he says, "have had the effect of introducing uncertainty in areas where we used to think there was a considerable amount of certainty—that is, a state's proprietary rights to the management of water resources." As a result of his various research interests, Cummings says, he is "comfortable with and appreciative of research conducted by my colleagues in systems engineering, operations research, and hydrology, as well as those in economics, law, and other social sciences."

To cover a wide spectrum of policy issues, Cummings believes, is appropriate for a multidisciplinary journal like WRR. In a recent editorial in the journal, he wrote "in our search for papers to be published in WRR we look, very simply, for new ideas—ideas which may provoke us, stimulate us, or appeal to our imagination. Whether a two-page theoretical breakthrough or a penetrating analysis of the strengths and weaknesses of the corpus of water laws, our goal for WRR has been and continues to be that of being the repository for integrative, interdisciplinary contributions."

The journal's new associate editors, including specialists in political science issues, municipal uses of water, and agricultural issues, reflect Cummings' efforts to "broaden the input of the social sciences." He has already planned a special journal issue, to appear early next year, on legal issues, which, he says, are among the "hottest" issues related to water in the West.

Asked what his goals are for his editorial term, Cummings says that "my greatest hope would be to walk away and feel that the integration of research in the social and natural sciences was made a bit more robust."—*TR*

AGU Membership Applications

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary section affiliation.

Sergio Alonso (A), Michael J. Andersen (O), Penny J. Barton (T), Brian Beers (SA), Nicholas L. Bogen (T), Beverly Burnett (O), Thomas J. Conway (A), Alain Dievlin (H), Joanne Hershenhorn (H), Benjamin F. Hobbs (H), Yoshihisa Kato (G), Benjamin J. Korgen (O), Hrefna Kristmannsdottir (G), Mark Ledgard (H), Carol S. Lydic (GP), Stanislaw R. Massel (O), Charles McCreery (S), Tim L. McDougall (H), Hugh G. McDowell (S), David Menzel (O), R. Pflug (T), David B. Smith (V), Guntarto Soekadas (G), Sigurdur Steinthorsson (V), David B. Watson (H), James Zollweg (S).

Students

R. B. Aldrich (H), Miguel Angel Alvarado-Omana (O), Olaitan Balogun (H), Timothy J. Bralower (O), Sara K. Culley (O), Peter Dillon (G), Jurriaan Gerretsen (V), Gustavo J. Goni (O), Robyn A. Grimes (H), W. Steven Holbrook (T), Michael McGrum (V), Lisa Osen (H), Karl F. Pohlmann (H), Russell M. Reimann (S), Sean T. Rooney (S), Roger Stoffregen (V), George D. Vassiliou (A).

Do you know a colleague who would like to join AGU?
Call 800-424-2488
and request membership applications.

Meetings

Announcements

Geophysics and Geodesy

November 5–9, 1984 13th Scientific Meeting of Geophysicists and Geodesists, San Carlos de Bariloche, Argentina. Organizer: Argentine Association of Geophysics and Geodesy. (Lic. Francisco Hirsch, Asociación Argentina de Geofisicas y Geodestas, Casilla de Correo 106, Sucursal 28, (1428) Capital Federal, Argentina.)

The meeting will include scientific sessions on geomagnetism, seismology, oceanography, meteorology, geodesy, and other topics of interest to geophysicists and geodesists. There will also be two joint symposia with the 9th Argentine Congress of Geology, sponsored by the Argentine Association of Geology. These symposia will cover cratonic and movable areas and applied geology and geophysics.

Geophysics in Kansas

November 13–14, 1984 Symposium on Geophysics in Kansas—A 25-Year Update, Wichita, Kan. Sponsors: Kansas Geological Survey, University of Kansas. (Conferences and Special Programs, University of Kansas, Continuing Education Building, Lawrence, KS 66045–2607.)

The symposium will examine the state of Kansas from a geophysical point of view by means of courses and sessions on a variety of topics, including the geology of the state, studies of specific geological features such as the Salina Basin and the Morrow Trend, and various mapping and data collection techniques as used in the state. A review and outline course on geophysical techniques for geologists is also available.

Wastewater Treatment

Nov. 20–21, 1984 7th International Symposium on Wastewater Treatment, Montreal, Canada. Organizers: Environment Canada, Société Québécoise d'assainissement des eaux, Association Québécoise des techniques des eaux. (Alain Jolicoeur, Environment Canada; telephone: 819-997-3405; or Claude Vergès, LAB-TEQ/Sonexeau, AQTE Representative; telephone: 514-636-5025.)

The symposium will cover both wastewater treatment and related topics, including control and instrumentation, treatment of industrial effluents, technological innovations, and treatment of municipal wastewater and sludges. A session on current research topics, such as anaerobic digestion, will also be presented. In addition, a special luncheon conference will highlight the activities of the Montreal Biotechnology Center.

Tropical Hydrology

Spring 1985 International Symposium on Tropical Hydrology, San Juan, Puerto Rico. Organizer: American Water Resources Association. (Ferdinand Quinones, U.S. Geological Survey, WRD, GPO Box 4424, San Juan, PR 00936; telephone: 809-783-4660.)

The deadline for abstracts, which should be submitted in triplicate and should not exceed 200 words, is November 1, 1984.

Since the hydrology of tropical regions is not well known, this symposium should be of interest to many involved in water resources research. Sessions will be presented on surface water systems, rainfall runoff characteristics in tropical climates, floods in tropical zones, the hydrology of small tropical islands, the hydrology of karst terrain in tropical zones, and other topics. Papers are invited on research, technical, and operational aspects of tropical hydrology and water resources management.

Subsurface Flow

June 3–7, 1985 Symposium on Stochastic Approach to Subsurface Flow, Fontainebleau, France. Sponsors: GRECO Hydrogeology of the Centre National de la Recherche Scientifique, Paris School of Mines. (G. de Marsily, GRECO Hydrogeologie, Ecole des Mines de Paris, Centre d'Informatique Géologique, 35, rue Saint-Honoré, 77305 Fontainebleau Cédex, France; telephone: 6–422–48–21.)

The deadline for the submission of abstracts is November 15, 1984.

The symposium will be organized into six general areas: stochastic definition of the microscopic and macroscopic parameters of porous media, in situ data collection and processing, stochastic description of single-phase flow, stochastic description of multiphase flow, stochastic description of transport processes in porous media, and stochastic analysis of fractured media. Papers will be presented at sessions organized around these topics.

Groundwater Contamination and Reclamation

August 14–15, 1985 Symposium: Groundwater Contamination and Reclamation, Tucson, Ariz. Organizer: American Water Resources Association. (Nathan Buras, Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721; telephone: 602-621-5082 or Kenneth D. Schmidt, 4120 North 20th St., Suite G, Phoenix, AZ 85016; telephone: 602-956-8711.)

The deadline for the submission of abstracts, which should be submitted in triplicate and should not exceed 200 words, is November 15, 1984.

Meetings (cont. on p. 760)

Meetings *(cont. from p. 759)*

This symposium is being held in conjunction with the 21st Annual Water Resources Conference of the American Water Resources Association; it will include both contributed and invited papers. Topics for paper sessions will include case histories of groundwater pollution, legal aspects of groundwater contamination and cleanup, the public perception of groundwater pollution, limitations of groundwater reclamation projects, and the economics of aquifer restoration, among others.

AGU Fall Meeting ASLO Winter Meeting

Housing, Registration, and Program Summary

The 1984 Fall Meeting of the American Geophysical Union and the Winter Meeting of the American Society of Limnology and Oceanography (ASLO) will be held in San Francisco, December 3–7, at the Civic Auditorium.

San Francisco has been host to AGU's annual Fall Meeting for many years. If you have attended previous Fall Meetings, you know what a pleasing city San Francisco can be—fine restaurants, temperate December climate, and the charms of Chinatown, Ghirardelli Square, Fisherman's Wharf, Nob Hill, and North Beach. San Francisco is an elegant city, offering a rich blend of stylish hospitality and hometown amiability. By any measure, San Francisco is an ideal backdrop for this year's scientific sessions.

Registration

Everyone who attends the meeting must register. Preregistration received by November 9 saves you time and money. The fee will be refunded to you if AGU receives written notice of cancellation by November 30. Registration rates are as follows:

	Preregistration	After November 9
Member (AGU/ASLO)	$70	$85
Student Member (AGU)	$30	$45
Retired Senior Member* (AGU/ASLO)	$30	$45
Nonmember	$95	$110
Student Nonmember	$40	$55

*Age 65 or over and retired from full-time employment.

Registration for 1 day is available at one half the above rates, either in advance or at the meeting. Members of the American Congress on Surveying and Mapping, the American Meteorological Society, the American Society of Photogrammetry, the Canadian Geophysical Union, the European Geophysical Union, and the Union Geofisica Mexicana may register at the AGU/ASLO member rates.

If you are not a member of AGU and you register at the full nonmember meeting rate, the difference between member (or student member) registration and nonmember registration will be applied to 1985 AGU dues if a completed membership application is received at AGU by February 28, 1985.

To preregister, fill out the registration form and return it with your payment to AGU by November 9. Preregistrants should pick up their registration material at the registration desk located at the Civic Auditorium in the Main Arena. Your receipt will be included with your preregistration material. Registration hours are 7:45 A.M. to 4:30 P.M., Monday through Friday. On Sunday, December 2, registration will be held at the Cathedral Hill Hotel. You may register from 4:00 P.M. to 8:00 P.M.

Hotel Accommodations

Blocks of sleeping rooms are being held at the following hotels:

- Cathedral Hill Hotel ($51 single/$55 double)
  Free parking to registered guests
  Limited shuttle service to and from the Civic Auditorium
  Airport shuttle service available
  Coffee shop opens 6:30 A.M.
- Holiday Inn Golden Gateway ($49 single/$55 double)
  Free parking to registered guests
  Limited shuttle service to and from the Civic Auditorium
  Airport shuttle service available
  Coffee shop opens 6:30 A.M.
- The Grosvenor Inn ($49 single/$55 double)
  Limited shuttle service to and from the Civic Auditorium
  Airport shuttle service available
  Coffee shop opens 7:00 A.M.
- The Holiday Inn Civic Center ($49 single/$55 double)
  Two blocks away from the Civic Auditorium
  Free parking to registered guests
  Airport shuttle service available
  Coffee shop opens 6:30 A.M.
- The San Franciscan Hotel ($50 single/$56 double)
  One block away from the Civic Auditorium
  Airport shuttle service available
  Parking $3 a day to registered guests
  Coffee shop opens 6:30 A.M.
- Carriage Inn Hotel ($52 single/$54 double)
  Victorian style inn
  Free parking to registered guests
  Walking distance to the Civic Auditorium
  Shuttle service available to airport
  Free continental breakfast and newspaper
- Americania Hotel ($49 single/$54 double)
  Free parking to registered guests
  Walking distance to the Civic Auditorium
  Shuttle service available to airport
  Free coffee served in sleeping rooms
- Flamingo Motor Inn ($43 single/$43 double)
  Free parking to registered guests
  Walking distance to the Civic Auditorium
  Shuttle service available to airport
- Hotel Britton ($35 single/$38 double)
  Inexpensive parking available to registered guests
  Walking distance to the Civic Auditorium
  Coffee shop opens 7:00 A.M.
  Shared baths

The Cathedral Hill, Holiday Inn Golden Gateway, and the Grosvenor hotels are approximately a mile away from the Civic Auditorium. Limited shuttle bus service will be provided from these hotels to the Civic Auditorium for those who do not want to walk.

Read the housing application and mail the completed application form to the housing bureau early to ensure reservations at your preferred hotel. Reservation forms must be sent directly to the Housing Coordinator, AGU Fall Meeting, San Francisco Housing Bureau, P.O. Box 5612, San Francisco, CA 94101. Do not send housing reservation forms to the hotel.

Reservations must be received by October 31 to be confirmed. Do not write or call AGU for room reservations.

Scientific Sessions

The program summary appears in this issue of *Eos*. The preliminary program with the abstracts will be published in the November 6 issue of *Eos*. The final meeting program, with presentation times, will be distributed at the meeting. All scientific sessions will be held at the Civic Auditorium.

Poster Sessions

Poster sessions will be held throughout the meeting in the Main Arena. AGU will provide each poster session presenter with a mounting area (board) measuring 4 × 6 feet (1.25 × 2 m). Plan your exhibit to fit this space. The boards will be assigned by numbers corresponding to the presenter's abstract number and will be set up in the Main Arena on Monday, December 3, by 9:00 AM. You may set your poster display up at 9:00 AM on the day for which it is scheduled and leave it up until 5:00 PM that day. You are required to be available at your display for at least 1 hour during the time for which your session is scheduled. Check the program for detailed scheduling time of poster sessions. Thumb tacks, push pins, tape, and scissors will be available in the meeting room.

Exhibits

Exhibits of instrumentation equipment, book publishers, program of government agencies, and other exhibits will be located at the Civic Auditorium in the Main Arena. The exhibits will be open Tuesday, December 4, through Thursday, December 6, 9:00 A.M. to 5:00 P.M. daily.

The following exhibitors are confirmed to date:

AANDERRA Instruments, Inc.
Academic Press
American Congress on Surveying and Mapping
American Society of Limnology and Oceanography
Applied Microsystems
Bordas, Dunod, Gauthier Villars
Earth Data Limited
Elsevier Science Publishing Company, Inc.
ENDECO, Inc.
Jet Propulsion Laboratory/Pilot Ocean Data
Jet Propulsion Laboratory/TOPEX Project
Kinemetrics, Inc.
Kluwer Academic Publishers (D. Reidel)
National Science Foundation
Nature's Own
NOAA/NEDRES
Pacific Delight
Qualimetrics, Inc./Weathertronics
Schonstedt Instrument Company
Sea-Bird Electronics, Inc.
Sprengnether Instruments
Springer-Verlag, New York Office
Teledyne Geotech
Terra Technology Corporation
University of Wyoming, Geology Department
U.S. Geological Survey

Career and Family: Making It Work

AGU Fall Meeting
Wednesday, December 5
6:00–8:00 P.M.
Crystal Ballroom
San Franciscan Hotel

Connie Sancetta of Lamont-Doherty Geological Observatory will moderate a discussion of how best to balance active involvement in a career with having and raising children. Panelists will be Tanya Atwater (University of California, Santa Barbara), Suzanne Beski-Diehl (Michigan Technological University), Laurie Brown (University of Massachusetts) and Sylvia Garzoli (Lamont-Doherty Geological Observatory).

This program has been arranged by the AGU Education and Human Resources Committee. Refreshments will be available.

RETURN THIS FORM WITH PAYMENT TO:

Meeting Registration
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

Or Call: Toll free 800-424-2488
or
Meetings 202-462-6903

PLEASE PRINT CLEARLY

NAME ON BADGE ____________________

AFFILIATION (for badge) ____________________

MAILING ADDRESS ____________________

TELEPHONE # ____________________
HOTEL ____________________

Days you plan to attend
Please check the appropriate box(es)

☐ Mon ☐ Tues ☐ Wed ☐ Thur ☐ Fri

Please check appropriate box.
Members of ASLO and the cooperating societies may register at AGU member rates
☐ Member AGU ☐ Member ASLO
Member cooperating society
☐ AMS-American Meteorological Society
☐ ASP-American Society of Photogrammetry
☐ ACSM-American Congress on Surveying and Mapping
☐ EGU-European Geophysical Union
☐ UGM-Union Geofisica Mexicana
☐ CGU-Canadian Geophysical Union

Nonmembers

If you register at the full-meeting nonmember rate, the difference between member (or student member) registration and nonmember registration will be applied to AGU dues if a completed membership application is received at AGU by February 28, 1985.

Preregistrants

Your receipt will be in your preregistration packet. The registration fee will be refunded if written notice of cancellation is received in the AGU office by November 30. The program and meeting abstracts will appear in the November 6 issue of *Eos*.

AGU 1984 Fall Meeting DECEMBER 3–7

San Francisco, California
ASLO WINTER MEETING

REGISTRATION FORM

Deadline for Receipt of Preregistration November 9, 1984

(rates applicable only if received by November 9 with payment)

	More than one day	One day
MEMBER	☐ $70	☐ $35
STUDENT MEMBER	☐ $30	☐ $15
*RETIRED SENIOR MEMBER	☐ $30	☐ $15
NONMEMBER	☐ $95	☐ $47.50
STUDENT NONMEMBER	☐ $40	☐ $20

*Age 65 or over and retired from full-time employment

SECTION LUNCHEONS

Circle section and indicate number of tickets. All lunches begin at noon.

____ Geomagnetism and Paleomagnetism, Tuesday, $8.50
____ Planetology/Volcanology, Geochemistry and Petrology, Tuesday, $11.50
____ Seismology, Tuesday, $7.50
____ Geodesy, Wednesday, $11.50
____ Ocean Sciences/ASLO, Wednesday, $11.50
____ Solar-Planetary Relationships, Wednesday, $11.50
____ Atmospheric Sciences, Thursday, $11.50
____ Hydrology, Thursday, $11.50
____ Tectonophysics, Thursday, $11.50

Total Enclosed $ ____________________
(All orders must be accompanied by payment or credit card information. Make check payable to AGU.)

Charge to: ☐ American Express
☐ Visa
☐ Master Card

Card Number ____________________
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Expiration Date ____________________
Signature ____________________

Office Use | Code | Check No.

Social Functions

All meeting participants are invited to attend these events:

- Icebreaker party
  Monday, 6:00–7:30 P.M.
  Holiday Inn Golden Gateway
- Wine Reception
  Thursday, 6:00–7:30 P.M.
  Cathedral Hill Hotel
- Complimentary refreshments will be served daily at the Civic Auditorium

Business Meetings and Section Luncheons

The AGU Council will meet Tuesday, December 4, at 5:30 P.M., at the Cathedral Hill Hotel. Members are welcome to attend.

ASLO will hold a no-host smoker (cash bar), Tuesday, December 4, at 5:30 P.M., at the Cathedral Hill Hotel

The section luncheons will be held at the San Franciscan (SF) and Holiday Inn-Civic Center (HICC) hotels. Please indicate on the registration form which luncheon you plan to attend and include payment.

AGU Council Meeting
Tuesday, December 4, 5:30 P.M.
Cathedral Hill Hotel

ASLO No-Host Smoker
Tuesday, December 4, 5:30 P.M.
Cathedral Hill Hotel

Tuesday, December 4, Noon
Geomagnetism and Paleomagnetism (HICC), Gold Ballroom, $8.50
Planetology/Volcanology, Geochemistry, and Petrology (SF), Corinthian Room, $11.50
Seismology (SF), Crystal Ballroom, $7.50, Speaker: William L. Ellsworth, USGS; Topic: "We Are Closer Than You Think to Earthquake Prediction"

Wednesday, December 5, Noon
Geodesy (SF), Corinthian Room, $11.50
Ocean Sciences/ASLO (SF), Crystal Ballroom, $11.50, Speaker: John Imbrie, Brown University; Topic: "Climatic and Biotic Response to Long-Term Changes in the Earth's Orbit"
Solar Planetary Relationships (HICC), Gold Ballroom, $11.50, Speaker: Fredrick L. Scarf, TRW; Topic: "Solar-Planetary Programs 1995–2015: A Plea for New Ideas"

Thursday, December 6, Noon
Atmospheric Sciences (HICC), Gold Room C, $11.50
Hydrology (HICC), Gold Room A and B, $11.50
Tectonophysics (SF), Crystal Ballroom, $11.50, Speaker: Barry Raleigh, Director, L-DGO

Program Summary

Union
Sea Level Change, Tues AM
Nuclear Waste Disposal, Wed AM

Atmospheric Sciences
Atmospheric Chemistry I, Mon PM
NASA GTE/CITE, Tues AM
Atmospheric Chemistry II, Tues PM
Atmospheric Chemistry III, Wed AM
Atmospheric Electricity I, Wed AM
Atmospheric Chemistry IV, Wed PM
Atmospheric Electricity II, Wed PM
Acid Deposition Modeling I, Thurs AM
Acid Deposition Modeling II, Thurs PM
ENSO and the TOGA Program, Fri AM
Atmospheric Sciences, Fri AM
Mesoscale Convective Systems, Fri PM

Geodesy
Seafloor Deformation, Mon AM
Premonitory Deformation, Mon PM
Geodetic Intercomparison, Tues AM
VLBI and Laser Ranging, Tues PM
GPS, SEASAT, and Theory, Tues PM
Instrumentation Development, Wed AM
Sea Surface, Geoid, Polar Motion, Wed PM

Geomagnetism & Paleomagnetism
Rock Magnetism, Mon AM
Asia and Africa, Mon PM
Data Analysis, Mon PM
North American APWP, Tues AM
GP Poster, Tues PM
Induction and Conductivity, Wed AM
Terrane Displacements, Wed PM
Transitions, Magnetostratigraphy, Thurs AM
Main Field, SV, Thurs PM
Anomalies, Crustal Structure, Thurs PM

Hydrology
ET Modeling I, Mon AM
ET Modeling II, Mon PM
History Of Hydrology, Tues AM
Snowmelt Runoff Modeling, Tues AM
General Surface Water I, Tues PM
Water Resources Issues, Tues PM
QPF Models I, Wed AM
QPF Models II, Wed PM
Microbes in Groundwater, Wed PM
General Surface Water II, Wed PM
General Hydrology Poster, Wed PM
Groundwater Isotopes I, Thurs AM
Dam Safety, Thurs AM
Contaminants in Sediments I, Thurs AM
Groundwater Isotopes II, Thurs PM
General Groundwater I, Thurs PM
Contaminants in Sediments II, Thurs PM
Paleoflood Hydrology I, Fri AM
General Groundwater II, Fri AM
Paleoflood Hydrology II, Fri PM
Water Quality Uncertainty, Fri PM

ASLO
Photocycles and Plankton, Mon AM
Arctic/Subarctic Limnology, Mon AM
Phytoplankton, Mon PM
Larval Ecology, Mon PM
Biochemical Approaches, Tues AM
Lakes, Tues AM
Zooplankton Processes, Tues PM
Sulfur Cycling, Tues PM
Estuaries, Wed AM
Warm Core Rings, Wed AM
El Nino, Wed PM
Bio-Optics, Wed PM
Warm Core Rings, Wed PM
Nitrogen Cycles I, Thurs AM
Southern Oceans I, Thurs AM
(SUPER), Thurs AM
Biology/Chemistry, Thurs AM
Nitrogen Cycles II, Thurs PM
Southern Oceans II, Thurs PM
Vertical Transport, Fri AM
Small-Scale Physics, Fri AM
Bacteria/Protozoans, Fri PM
Zooplankton/Fish, Fri PM
Columbia River, Fri PM

Ocean Sciences
Mid-Latitude Circulation I, Mon AM
Ice Margin I, Mon AM
Benthic Fluxes I, Mon AM
Ice Margin II, Mon PM
Ancient Oceans, Mon PM
Benthic Fluxes II, Mon PM
Tropical Pacific I, Tues AM
California Currents, Tues AM
Redox Processes, Tues AM
Ocean Dynamics, Tues AM
Tropical Pacific II, Tues PM
Sea Level II, Tues PM
Geochemistry of Sediments, Tues PM
Geochemistry/Stratigraphy, Tues PM
Tropical Atlantic I, Wed AM
Near-Shore Processes I, Wed AM
Early Diagenesis I, Wed AM
Tropical Atlantic II, Wed PM
Upwelling, Wed PM
Near-Shore Processes II, Wed PM
Early Diagenesis II, Wed PM
Air-Sea Interaction I, Thurs AM
Air-Sea Interaction II, Thurs AM
Marginal Seas and Straits I, Thurs AM
Chemical Tracers, Thurs AM
Air-Sea Interaction III, Thurs PM
Marginal Seas and Straits II, Thurs PM
Trace Metals, Thurs PM
Coastal Ocean Dynamics I, Thurs PM
Coastal Ocean Dynamics II, Fri AM
Quaternary Paleoceanography, Fri AM
Hydrothermal Processes, Fri AM
Coastal Ocean Dynamics III, Fri PM
Mid-Latitude Circulation II, Fri PM

Planetology
Water on Mars I, Mon AM
Water on Mars II, Mon PM
Io Physical Properties I, Tues AM
Io Physical Properties II, Tues PM
Venus Surface and Potpourri, Wed AM
Comets and Venus, Wed PM

Seismology
Continental Lithosphere I, Mon AM
Prediction and Hazards, Mon AM
Continental Lithosphere II, Mon PM
Seismic Sources, Mon PM
Continental Lithosphere Posters, Mon PM
California Earthquakes I, Tues AM
Nuclear Explosion, Tues AM
California Earthquakes II, Tues PM
Subduction Zones, Tues PM
Deep Earth Structure I, Wed AM
Volcanic Earthquakes, Wed AM
Deep Earth Structure II, Wed PM
Strong Motion, Wed PM
Ocean Lithosphere I, Thurs AM
Attenuation and Scattering, Thurs AM
Ocean Lithosphere II, Thurs PM
Geothermal and Hydrofracturing, Thurs AM
Ocean Lithosphere Posters, Thurs PM
Ocean Lithosphere III, Fri AM
Wave Propagation I, Fri AM
Intraplate Earthquakes, Fri PM
Wave Propagation II, Fri PM

SPR: Aeronomy
Airglow and Aurora I, Mon AM
Airglow and Aurora II, Mon PM
Aurora-Airglow Modeling I, Tues AM
Aurora-Airglow Modeling II, Tues PM
Ionosphere Electric Field I, Tues PM
Ionosphere Electric Field II, Wed AM
Thermospheric Dynamics, Wed PM
Stratosphere-Mesosphere, Thurs AM
Middle Atmosphere, Thurs PM
Oxygen Airglow, Fri AM
Atmospheric Sciences, Fri AM
Middle Atmosphere, Fri PM

SPR: Cosmic Rays
Cosmic Ray Modulation, Tues PM

Meetings *(cont. on p. 762)*

Nominations for AGU Medals and Awards

William Bowie Medal. Awarded for outstanding contributions to fundamental geophysics and for unselfish cooperation in research.

Waldo E. Smith Award. Given for extraordinary service to geophysics.

John Adam Fleming Medal. Awarded for original research and technical leadership in geomagnetism, atmospheric electricity, aeronomy, and related sciences.

Walter H. Bucher Medal. Given for original contributions to the basic knowledge of the earth's crust.

Maurice Ewing Medal. Honors an individual who has led the way in understanding physical, geophysical, and geological processes of the ocean; who is a leader in scientific ocean engineering, technology, and instrumentation; or who has given outstanding service to marine sciences.

James B. Macelwane Award. Up to three awards are given each year for significant contributions to the geophysical sciences by a young scientist of outstanding ability. Recipients must be less than 36 years old on November 1 of the year preceding presentation of the award.

Send letters of nomination outlining significant contributions and curricula vitae directly to the appropriate committee chairman.

For the Bowie Medal:
Donald L. Turcotte
Department of Geological Sciences
Cornell University
Ithaca, New York 14850

For the Bucher Medal:
Rob Van der Voo
Department of Geological Sciences
University of Michigan
Ann Arbor, Michigan 48109

For the Smith Award:
J. Freeman Gilbert
IGPP A-025
University of California, San Diego
La Jolla, California 92093

For the Ewing Medal:
John M. Edmond
E34-266
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

For the Fleming Medal:
Thomas M. Donahue
Department of Atmospheric and Ocean Sciences
University of Michigan
Ann Arbor, Michigan 48104

For the Macelwane Award:
Adam M. Dziewonski
Department of Geology
Harvard University
Cambridge, Massachusetts 02138.

Deadline for Nominations is November 1, 1984

Meetings (cont. from p. 761)

Energetic Particles, Thurs PM
SPR: Magnetospheric Physics
Magnetopause Dynamics I, Mon AM
Planetary Magnetospheres I, Mon AM
Magnetopause Dynamics II, Mon PM
Planetary Magnetospheres II, Mon PM
Space Lab I, Tues AM
Outer Radiation Belt Dynamics, Tues AM
Space Lab II, Tues PM
ULF Dynamics, Tues PM
Plasma Sheet Dynamics I, Wed AM
Space Plasma Theory, Wed AM
Plasma Sheet II/AMPTE, Wed PM
Plasma Sheet Dynamics III, Thurs AM
Controlled Beams and Waves, Thurs AM
Magnetosphere/Ionosphere, Thurs AM
Auroral Dynamics I, Thurs PM
Beams/Waves/Particles, Thurs PM
Auroral Dynamics II, Fri AM
Particles/Waves/Theory, Fri AM
Auroral Dynamics III, Fri PM
SPR: Solar & Interplanetary Physics
SMM Repair & Results, Mon AM
Solar Wind, Mon PM
Solar Physics, Tues AM
SMM Repair and Results (P), Wed AM
Sun & SW Plasma Processes, Wed AM
Shocks and Upstream Waves, Thurs AM
Tectonophysics
Cracks and Rock Fracture, Mon AM
Seamounts I, Mon AM
Joint and Gouge Properties, Mon PM
Seamounts II, Mon PM
Physical Properties/Tectonics, Mon PM
Marine Tectonics, Mon PM
General Tectonophysics, Mon PM
John C. Jamieson Memorial I, Tues AM
Geodynamics I, Tues AM
Accretion of Sediments, Tues AM
John C. Jamieson Memorial II, Tues PM
Geodynamics II, Tues PM
Continental Tectonics, Tues PM
Continental Drilling I, Wed AM
Fluids and Rock Deformation, Wed AM
Rock Fabrics and Anisotropy, Wed AM
Plate Motions, Wed AM
Continental Drilling II, Wed PM
Marine Geophysics, Wed PM
Mineral Physics, Thurs AM
Frontiers, Thurs AM
Rock Rheology, Thurs PM
South American Tectonics, Thurs PM
Juan de Fuca Ridge, Thurs PM
Fault Mechanics, Fri AM
Rifts and Basins, Fri AM
Long Valley Caldera, Fri AM
Regional Tectonics, Fri PM
Heat Flow, Fri PM
Volcanology, Geochemistry, & Petrology
Igneous Petrology, Mon AM
Ore Pet. & Alteration, Mon AM
Diagenesis/Res. Flow, Mon PM
Rhyolites, Mon PM
Archean, Tues AM
Kilauea and Haleakala, Tues AM
Volcanology, etc., Tues AM
Arc Petrology and Geology, Tues PM
Mauna Loa & Maui, Tues PM
Seafloor Petrology, Wed AM
Glass and Melt Physics, Wed AM
Magma Mechanics, Wed PM
Mineral Thermophysics, Wed PM
Volcanology I, Thurs AM
Ophiolites/Metamorphism, Thurs AM
Volcanology II, Thurs PM
Exp. Pet. & Analytical, Thurs PM
Granites & Isotopes, Fri AM
Basalts/Nodules, Fri PM

Guidelines for Giving a Truly Terrible Talk

Strict adherence to the following time-tested guidelines will ensure that both you and your work remain obscure and will guarantee an audience of minumum size at your next talk. Continuity of effort may result in being awarded the coveted 5:00 P.M. Friday speaking time at the next national meeting.

Slides

1. Use lots of slides. A rule of thumb is one slide for each 10 seconds of time allotted for your talk. If you don't have enough, borrow the rest from the previous speaker, or cycle back and forth between slides.
2. Put as much information on each slide as possible. Graphs with a dozen or so crossing lines, tables with at least 100 entries, and maps with 20 or 30 units are especially effective; but equations, particularly if they contain at least 15 terms and 20 variables, are almost as good. A high density of detailed and marginally relevant data usually preempts penetrating questions from the audience.
3. Use small print. Anyone who has not had the foresight to either sit in the front row or bring a set of binoculars is probably not smart enough to understand your talk anyway.
4. Use figures and tables directly from publications. They will help you accomplish goals 2 and 3 above and minimize the amount of preparation for the talk. If you haven't published the work, use illustrations from an old publication. Only a few people in the audience will notice anyway.

Presentation

1. Don't organize your talk in advance. It is usually best not to even think about it until your name has been announced by the session chair. Above all, don't write the talk out, for it may fall into enemy hands.
2. Never, ever, rehearse, even briefly. Talks are best when they arise spontaneously and in random order. Leave it as an exercise for the listener to assemble your thoughts properly and make some sense out of what you say.
3. Discuss each slide in complete detail, especially those parts irrelevant to the main points of your talk. If you suspect that there is anyone in the audience who is not asleep, return to a previous slide and discuss it again.
4. Face the projection screen, mumble, and talk as fast as possible, especially while making important points. An alternate strategy is to speak very slowly, leave every other sentence uncompleted, and punctuate each thought with "ahhh," "unhh," or something equally informative.
5. Wave the light pointer around the room, or at least move the beam rapidly about the slide image in small circles. If this is done properly, it will make 50% of the people in the front three rows (and those with binoculars) sick.
6. Use up all of your allotted time and at least half, if not all, of the next speaker's. This avoids foolish and annoying questions and forces the chairman to ride herd on the following speakers. Remember, the rest of the speakers don't have anything important to say anyway. If they had, they would have been assigned times earlier then yours.

If the above doesn't suit your style or goals, then perhaps the following alternate guidelines will be more useful.

Make a Better Presentation

Slide Preparation

General Principles

1. Slides must be well designed, simple, and readable by everyone in the audience. It is worthwhile to use professional slide preparation services, if available.
2. Use as few slides as are really needed and can be discussed in the time allotted. As a general rule, one slide for each 1 or 2 minutes of presentation is all that will be effective.
3. Devote each slide to a single fact, idea, or finding. Illustrate major points or trends, not detailed data. Do not show long or complicated formulas or equations. Each slide should remain on the screen at least 20 seconds.
4. Use the absolute minimum number of words in titles, subtitles, and captions. Remember that standard abbreviations are acceptable.
5. Use block lettering. Do not use serifs or italics. A rule of thumb for the minimum height of readable lettering (size) is 3 millimeters on the finished slide. Do not make slides from illustrations or tables that were prepared for publication. They are rarely satisfactory. A good way to test your material is to stand away 1 foot for every inch of original copy width. If you can't read it from that distance, then your audience will not be able to read it either when it is projected.
6. Color adds attractiveness, interest, and clarity to slide illustrations and should be used whenever possible. If you use color, remember that contrasting colors are easier to see.
7. Use 2" x 2" paper or plastic mounted slides, designated for a 35 mm slide projector. Be sure that they are clean and in good physical condition.
8. Critically examine every slide, and try out the entire set under adverse light conditions before using them at a meeting. It is sometimes impossible to provide excellent light conditions at meetings.
9. Mark a large positioning dot or make a notch in the lower left hand corner of each slide when it is laid flat so it may be read; rotate 180° for loading into a carousel. A notch makes it easy to see that all slides are in correct position in a tray. Number every slide in proper sequence, and give them to the projectionist exactly as you wish them shown. This is important, because slides may be dropped or become disarranged. Come a few minutes before the start of the session to give the projectionist time to arrange your slides for presentation.

Tables

1. Do not use more than three or four vertical columns; six to eight horizontal lines. Any more and the information will not be readable.
2. Do not use ruled vertical or horizontal lines. They distract the eye and clutter the slide.
3. Whenever possible, present data by bar charts or graphs instead of tables. Colored graphs are very effective.

Graphs

1. Generally, do not use more than one or two curves on one diagram; three to four as maximum but only if well separated.
2. Label each curve; do not use symbols and legend.
3. Do not show data points unless scatter is important.

Presentation

1. Write the talk out in advance so that your ideas are logically organized and your points clear. At the very least, write out a detailed outline. Cover only the few essential main points, and leave the details for your publication.
2. Rehearse. If possible, give your talk to one or more colleagues, and ask them for suggestions for improvement. If the talk runs longer than the allotted time, eliminate the least essential material and rehearse again.
3. Speak slowly and clearly. Word choice should be simple: Use active words, short sentences. Words should reinforce visual material.
4. Out of consideration for the other speakers and the audience **stay within your allotted time**. This is essential to ensure adequate time for questions and discussion and adherence to schedule.
5. Use the public address system and speak into the microphone toward the audience at all times. If you need to see what is being shown on the screen, have pictures or copies at the speaker's rostrum.

For more information on preparing a technical slide show, the most detailed and possibly the best manual yet written, especially for technical and scientific slide users, is *35-mm Slides: A Manual for Technical Presentations* by Dan Pratt and Len Ropes, published by the American Association of Petroleum Geologists, 1978, 32 pages, $5.00 each; order from AAPG, Box 979, Tulsa, OK 74101.

Travel Funds to Fall Meeting Available to Foreign Graduate Students

Grants of up to $250 are available to foreign graduate students studying in the U.S. for travel to the AGU Fall Meeting, December 3–7 in San Francisco, California.

The funds, a grant from the Short-Term Enrichment Program (STEP) of the U.S. Information Agency, are available to full-time foreign graduate students who are not receiving ANY U.S. government funds. Students in refugee, immigrant or tourist visa status are not eligible.

For complete eligibility requirements and an application, write or call:

Member Programs Department
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, DC 20009
202-462-6903

Deadline: October 31, 1984

Meeting Report

Indo/U.S. Science and Technology Initiative: Monsoon Research

The United States and India have a new science and technology agreement for cooperation in four areas of research, one of which is monsoon prediction. The Indian monsoon and the prediction of monsoon rainfall on short time scales is of vital concern to India and is also a central element of the global atmospheric circulation. Its predictability depends not only upon its own dynamics but also upon the dynamics of the global circulation in which it is embedded. An understanding of monsoon dynamics is central to an understanding of the global circulation. Thus an improved knowledge of the interannual variability of the Asian monsoon should improve long-range weather prediction throughout the world. It is therefore of vital scientific and practical importance to both the United States and India.

Two major parts to the monsoon prediction program have been defined: numerical weather prediction of monsoons and long-range variability of the monsoon. The programs, as defined in the agreement between the two countries, and scientific task leaders were reported in *Eos* (April 26, 1983, p. 155). Ten tasks have been identified under the bilateral, and one task is specifically related to the ocean's role in the monsoon.

In April 1984 a delegation of 15 U.S. and 65 Indian scientists attended a workshop at the Indian Institute of Science (IISc.) in Bangalore on Ocean-Atmosphere Interactions as They Affect the Monsoon. The Indian host was Roddam Narasimha of IISc; Dennis Moore of University of Hawaii was the head of the U.S. delegation. The U.S. participants were Otis Brown and Rana Fine of University of Miami, David Halpern of NOAA/PMEL, Hanumanthaiah Lakshmikantha of Dynalysis of Princeton, Mark Luther of Florida State University, Julian McCreary and Jan Witte of Nova University, Michael McPhaden of the University of Washington, Christopher Mooers of the Naval Postgraduate School, Dennis Moore and Klaus Wyrtki of the University of Hawaii, John Morrison of the National Science Foundation, Desiraju Rao of NASA/Goddard, Mary Raymer of Woods Hole, and Subramanian SethuRaman of North Carolina State University. This was the first ocean meeting under the bilateral. The purpose was to plan a cooperative program addressing the role of the ocean in the short- and long-term variability of the monsoon.

Scientific presentations of observational data from the Indian Ocean focused on ocean circulation, ocean heat flux, and sea surface temperatures (SST's); modeling presentations focused on ocean-atmosphere coupled models, mixed layer and boundary layer experiments, and equatorial and coastal dynamics. The scientific talks served to channel the future work to be done under this agreement toward determining the influence of the Arabian Sea and the Bay of Bengal and eastern tropical Indian Ocean on the monsoon. The Arabian Sea is of interest because of the large seasonal cycle in the thermal field and ocean currents. The Bay of Bengal and eastern tropical Indian Ocean extending to Indonesia are of interest because the southeastern portion of that region is where large convective cloud systems form. These convective systems that migrate northward over the Indian subcontinent are a primary source of rainfall during the summer monsoon.

Five activities were discussed at the workshop. It was agreed that three activities may begin immediately:

1. Modeling: Workshop participants recommended development of models of the Arabian Sea cooling event and of the effect of near-equatorial oceanic circulation on the atmosphere; the latter will include both process-oriented and coupled ocean-atmosphere models. Models are also needed to investigate the response of the ocean to the 40–50 day oscillations in the atmosphere and to see if the ocean plays any role in driving these oscillations. Effects of coastal geometry on equatorial circulation should be modeled, and data assimilation models are needed, especially for the Arabian Sea and tropical equatorial region.
2. Analysis of existing data.
3. Satellite studies: Data analysis and satellite studies should include both historical and new satellite and ship data on radiance, sea surface temperatures, ocean thermal structure (bathythermographs, expendable bathythermograph (XBT), and hydrographic data), and air-sea fluxes for the various phases of the monsoon (onset, active, break, etc.). In particular, the relationship of the interannual variability of 10–15 and 40–50 day oscillations over the Asiatic monsoon region to the variability of the Indian and Pacific Oceans should be investigated. Historical ship data should be used to validate satellite-derived data, especially SST. Humidity profiles and aerosol data should be used to improve the accuracy of satellite SST determinations. The relationship between air-sea fluxes, SST, and monsoon rainfall and their interannual variability should also be explored using historical data. It was recommended that oxygen isotope data should be used to determine the moisture sources for monsoon rainfall.

Areas requiring further discussion are

4. Monitoring (sea level, XBT ships of opportunity, and drifters).
5. Process-oriented observational programs.

The two areas chosen for study are the Arabian Sea and the eastern tropical Indian Ocean.

Participants have agreed that preliminary to any major field program, there shall be a monitoring program of the large-scale ocean circulation and a pilot study. An Indian scientist is scheduled to visit the University of Hawaii this year to study the use of sea level data for monitoring ocean variability on seasonal and longer time scales. A pilot experiment has been proposed in one or both of the regions using XBT's in order to determine the temporal variations of the upper ocean thermal fields before and during the 1985 Southwest Monsoon. It is hoped that after the pilot study is completed, one or two major field experiments may be conducted jointly by U.S. and Indian scientists. The purpose of the field work will be to describe and understand the heating and cooling cycle of the upper ocean in the two regions and the effect of the ocean on air mass modification.

A joint working group to design process-oriented field experiments will be established.

Limited funds are available for cooperative research that specifically addresses the tasks under bilateral agreement. NSF is considering proposals from interested scientists. Proposals will be subject to the standard NSF peer review. Inquiries regarding the atmospheric component of the program should be addressed to Jay Fein or Pamela Stephens at National Science Foundation (telephone: 202-357-9887). Planning letters for the oceanography task defined above should be sent to both Dennis Moore (JIMAR/University of Hawaii, 1000 Pope Road, Honolulu, HI 96822) and John Morrison (Ocean Sciences Division/National Science Foundation, 1800 G Street, N.W., Washington, D.C. 20550).

This meeting report was written by Dennis W. Moore, JIMAR/University of Hawaii, 1000 Pope Road, Honolulu, HI 96822; Rana A. Fine, RSMAS/University of Miami, 4600 Rickenbacker Causeway, Miami, FL 33149; John Morrison, OCE/National Science Foundation, 1800 G Street, N.W., Washington, DC 20550.

Future AGU Meetings

Fall Meetings

Dec. 3–7, 1984, San Francisco, California.

Dec. 9–13, 1985, San Francisco, California. Abstracts due mid-September 1985.

Dec. 8–12, 1986, San Francisco, California.

Spring Meetings

May 27–31, 1985, Baltimore, Maryland. Abstracts due early March 1985.

May 19–23, 1986, Baltimore, Maryland.

Regional Meetings

Front Range Branch Symposium on Geophysics and Geology of Yellowstone, October 25, 1984, Golden, Colorado.

Front Range Branch Hydrology Days, April 16–18, 1985, Fort Collins, Colorado. Abstracts due December 31, 1984 for professional hydrologists, February 15, 1985 for students; call for papers appeared in July 24, 1984 *Eos*.

Chapman Conferences

Vertical Crustal Motion: Measurement and Modeling, October 22–26, 1984, Harpers Ferry, West Virginia.

Solar Wind-Magnetosphere Coupling, February 12–15, 1985, Pasadena, California. Abstracts due November 1, 1984; call for papers appeared in July 10, 1984 *Eos*.

Ion Acceleration in the Ionosphere and Magnetosphere, June 3–7, 1985, Boston, Massachusetts.

Magnetotail Physics, October 28–31, 1985, Laurel, Maryland.

The last Geophysical Year calendar ran August 28, 1984, in *Eos*.

GAP

Aeronomy

0410 Absorption and scattering of radiation (particles or waves)
THE ALTITUDE VARIATION OF THE IONOSPHERIC PHOTOELECTRON FLUX: A COMPARISON OF THEORY AND MEASUREMENT
P. G. Richards (Center for Atmospheric and Space Sciences, Utah State University, UMC 41, Logan, Utah 84322) and D. G. Torr

We compare the 165 to 300 km altitude variation of the measured photoelectron flux in the 13 to 18 eV, 28 to 34 eV, and 50 to 55 eV energy regions with the variations expected from theory. There is a strong linear relationship between the measured photoelectron flux and the attenuation of the solar EUV flux at these energies. Therefore, the photoelectron flux is sensitive to changes in the solar zenith angle, neutral density scale height, and total neutral density. However, contrary to previous assertions, the photoelectron flux at most energies is not sensitive to the relative densities of the neutral constituents. In addition, we obtain excellent agreement between theory and measurement. By using the concept of photoelectron production frequencies, we reduce the usually complex evaluation of the local equilibrium photoelectron flux to a trivial calculation so that the steps in the calculation can be readily verified.

J. Geophys. Res., A, Paper 4A9208.

0460 Tides, waves and winds
GLOBAL LARGE SCALE STRUCTURES IN THE F REGION
S. H. Gross (Department of Electrical Engineering/Computer Science, Polytechnic Institute of New York, Route 110, Farmingdale, New York 11735)

Measurements of neutral densities, temperature and ion density and temperature by the Atmosphere Explorer C and E satellites exhibit fluctuations made up of coherent waves of scale sizes from hundreds to thousands of kilometers. The fluctuations in the AE-C data are found at times of low magnetic activity to extend from the auroral region in one hemisphere across the equator to the corresponding region in the other hemisphere with little change in apparent wavelength. The fluctuations in the AE-E data similarly exhibit at times of low magnetic activity nearly uniform wave structure encircling the equatorial belt. Typical examples of 2000 km waves in the AE-C data and 1500 km waves in the AE-E data are discussed. To explain these observations, it is suggested that during quiet periods the auroral belts excite quasi-stationary waves distributed about the earth with tidal-like periods and scale lengths determined by the structure of the belts. According to this interpretation, TID's are manifestations of the transient waves tha result from changes in magnetic activity with periods and scale sizes associated with the auroral excitation.

J. Geophys. Res., A, Paper 4A8179.

Electromagnetics

0770 Radio Oceanography
SAR IMAGING OF WAVES IN WATER AND ICE: EVIDENCE FOR VELOCITY BUNCHING
D.R. Lyzenga (Radar Division, Environmental Research Institute of Michigan, Ann Arbor, MI, 48107), R.A. Shuchman, J.D. Lyden and C.L. Rufenach

Synthetic aperture radar (SAR) images collected over the Arctic marginal ice zone show gravity wave patterns in both the open water and the ice. Diffuse wave patterns are visible in the water at near range (small incidence angles), while more distinct wave patterns are visible in the ice across the entire swath. The wave patterns in the ice appear as bright lines rather than sinusoidal intensity variations. Additionally, the images show a periodic displacement of the ice/water boundary, apparently due to Doppler shift effects associated with the gravity wave orbital motions. These observations are interpreted as evidence for the velocity bunching effect, and also illustrate the effects of random scatterer motions in the open water (SAR imaging, ocean waves).

J. Geophys. Res., C, Paper 4C1128.

0773 Remote Sensing
THE DEPENDENCE OF X-BAND MICROWAVE SEA RETURN
W. J. Plant (Space Sensing Applications Branch, Naval Research Laboratory, Washington, DC 20375), W. C. Keller, D. E. Weissman

The dependence of microwave sea return at an incidence angle in the Bragg regime on wind speed, atmospheric stability, dominant wave slope, and dominant wave frequency has been measured. The measurements were made from a tower in the Gulf of Mexico with a CW, X-band microwave system operating at a 45° incidence angle. Measured microwave parameters were relative cross sections and ocean wave-radar modulation transfer functions obtained with antennas directed into wind and waves. The data reveal that cross sections increase with decreasing z/L (z being height and L being the Obukhov length) in unstable atmospheric conditions. The rate of increase is much higher than that of surface stress calculated on the basis of present boundary layer models. Furthermore, these data indicate that in near-neutrally stratified atmospheric conditions, X-band cross sections at constant and relatively low wind speeds increase with long wave slope while modulation transfer functions decrease with long wave slope. No clear dependence of either parameter on wave slope was observed in highly unstable conditions. The implications of these findings for other microwave frequencies and for scatterometry and microwave imagery of the sea are briefly discussed. (scatterometry, radar oceanography, wind stress)

J. Geophys. Res., C, Paper 4C1204.

0780 Scattering
POLE AND RESIDUE EXTRACTION FROM MEASURED DATA IN THE FREQUENCY DOMAIN USING MULTIPLE DATA SETS
D. A. Kalonski (Radiation Laboratory, Department of Electrical and Computer Engineering, The University of Michigan, Ann Arbor, Michigan, 48109)

When the singularity expansion method is applied to measured data, the accuracy of the results is often severely limited by the noise and clutter present in the measurement. An effective method of reducing these contaminations is repeating and averaging the measurements. The effectiveness of this approach is related to the number of measurements which are combined. The present paper develops a method which expands the set of measurements which may be combined from the set of identical measurements to the set of all measurements made on the target. The measurements are combined using an optimal weighting scheme to provide a superior estimate for a specified pole. An algorithm is described which increases the accuracy of the estimated pole locations and accurately computes the residues associated with these new pole locations. The algorithm is used to extract a single pole and residue, and additional poles and residues may be obtained through iterative applicationof the algorithm. (Scattering, noise and interference).

Rad Sci., Paper 4S1164.

0780 Scattering
ANALYSIS OF SCALAR WAVE SCATTERING FROM SLIGHTLY ROUGH RANDOM SURFACES: A MULTIPLE SCATTERING THEORY
Shigeo Ito (Radio Research Laboratories, Ministry of Posts and Telecommunications, Koganei-shi, Tokyo 184, Japan)

An analytical approach to the problem of scalar wave scattering from a slightly rough random surface with the Dirichlet or the Neumann boundary condition is presented. The Green's function method is employed to analyze statistical characteristics of waves including multiple scattering. The integral equations for the first two moments of scattered waves are derived in a unified form for both boundary conditions. Iterative solutions for the intensity of coherent and incoherent waves are then obtained and are shown to satisfy energy conservation. The effects of multiple scattering due to surface roughness are incorporated systematically into those solutions through an effective surface impedance. Numerical results of the first-order solutions for the incoherent wave show that even for slightly rough surfaces multiple scattering effects are pronounced in the Neumann case at near-grazing incidence when the correlation length of the surface height is smaller than the wavelength. The results obtained are also compared with those previously obtained under the same perturbation boundary condition. (Radio oceanography, Remote sensing).

Rad. Sci, Paper 4S1130.

0780 Scattering (Frequency Selective Surfaces)
SCATTERING FROM AN INFINITE ARRAY OF PERIOD BROKEN WIRES BURIED IN A DIELECTRIC SHEET
J. G Gallagher (RSRE, St Andrews Road, Malvern, Worcs WR14 3PS, UK), D J Brammer

The scattering of a plane wave from a periodic broken-wire grid buried in a dielectric sheet is studied for a general angle of incidence and for arbitrary linear polarisation. The scattered field is expanded in a set of Floquet modes, and the modal coefficients are obtained through the current expansion for a reflecting antenna. The general formulation of the problem is applicable for grids in an infinite dielectric and when located at the boundary interface of two dielectrics. A moment method is used to determine the current on the grid elements and numerical results for the transmission characteristics of several different grid configurations are presented. In addition, the effect on the resonant frequency of parametric variations in the grid geometry is determined. Predicted results are compared with measured transmission characteristics and show excellent agreement.

Rad. Sci., Paper 4S1141.

0785 Tropospheric Propagation
THE FINESTRUCTURE OF ELEVATED LAYERS; IMPLICATIONS FOR OVER-THE-HORIZON PROPAGATION AND RADAR SOUNDING SYSTEMS
E. E. Gossard (CIRES, Univ. of Colorado), W. D. Neff, R. J. Zamora and J. E. Gaynor (Wave Prop. Lab. NOAA/ERL, Boulder, CO)

Radar and acoustic sounder data are compared with in-situ turbulence and meteorological data collected with fast response sensors on a carriage traversing a 300 m tower. The carriage data reveal a finestructure of sharp laminae within elevated inversions that is associated with laminated echoes in the sounder records. The zones of sharp gradient contain narrow regions of enhanced structure parameters of temperature and humidity that presumably account for the radar and acoustic returns from those zones. In these cases the temperature and humidity profiles are remarkably close (negative) replicas of each other, greatly simplifying the interpretation of radio refractive index from temperature data. A model of specular reflection is compared with a Bragg backscatter model, and it is concluded that specular contributions from the observed gradients can exceed the Bragg return even for backscatter if radar wavelengths greater than a few meters are used. For bistatic configurations the specular contributions should commonly exceed the tropospheric scatter contribution when elevated stable layers are present.

Rad Sci., Paper 4S1121.

0785 Troposheric Propagation (Rain Attenuation)
EHF ATTENUATION DERIVED FROM EMISSION TEMPERATURES IN LIGHT RAIN
F. I. Shimabukuro (Aerospace Corporation, El Segundo, California 90245), H. T. Tavis and D. S. Cheng

If one uses the radiometric relation to derive the attenuation from emission measurements in rain at EHF assuming an absorptive medium, one finds that the predicted attenuation underestimates the true attenuation. The reason for this is that the rain scatters more emission energy out of the direct ray path than into it. Calculations of the atmospheric emission temperature and attenuation in light to moderate rain at different frequencies and rain rates are performed, taking into account molecular absorption, and varying cloud cover and ground temperature. This results show that for typically encountered meteorological conditions, the radiometric formula can be used to derive the total attenuation (< 10 dB) from emission measurements with accuracies of the order less than 1 dB provided that the empirical constant in the radiometric formula, dependent on the ambient temperature, is a function of frequency and ground temperature. (rain emission, scattering, attenuation)

Rad. Sci., Paper 4S0891.

Exploration Geophysics

0920 Magnetic and electrical methods
A COMPARISON OF GRAVITY PREDICTION METHODS ON ACTUAL AND SIMULATED DATA
F. Foster Harrison (P.O. Box 2012, Rockville, MD 20852-0012) Bruce C. Douglas

A comparison was made between Shepard's method (inverse-distance weighting) and collocation (linear filtering) for the purpose of predicting gravity anomalies. Tests were made with actual data from southern California and with simulated data created from buried point masses generated by a random number generator. The autocorrelation functions of the simulated and actual gravity data were very much alike. In general, the sophisticated collocation method did produce better results and very good variance estimates, compared with Shepard's method, for simulated data. The advantage was less for actual data. The cost of the latter results is the use of more computer time. The most important scientific conclusion of this study is that careful trend removal must be done and an adequate data sample obtained to produce truly optimal results from collocation. The variance estimates are much more sensitive to the form and calibration of the model autocorrelation function than are the prediction results.

GEOPHYSICS, VOL 49, NO. 10

0930 Seismic methods
SIGNAL/NOISE SEPARATION AND VELOCITY ESTIMATION
William S. Harlan (Department of Geophysics, Stanford University, Stanford, CA 94305) Jon F. Claerbout and Fabio Rocca

A significance separation must recognize the statistical coherence of a geologic structure before extracting those components most useful for a particular process, such as velocity analysis. [illegible]

GEOPHYSICS, VOL 49, NO. 11

0930 Seismic methods
SEISMIC PARAMETERS FOR TRANSVERSELY ISOTROPIC MEDIA
Bok S. Byun (ARCO Oil and Gas Co., 2300 W. Plano Parkway, 935 PAT, Plano, TX 75075)

One of the most important problems in exploration seismology is to relate the surface seismic measurements with the subsurface geologic parameters. The concept of wavefront curvature has been in extensive use for this purpose. Byun (1982) developed relationships between several measurable seismic parameters (e.g., geometrical spreading and normal moveout velocity) and parameters of the media with elliptical velocity dependencies.

This paper extends the wavefront curvature concept to more general, transversely isotropic media. After a brief discussion on ray tracing, a procedure is developed to describe the local properties of the ray based on an elliptical surface fit to the actual wave surface. The apparent velocities of the elliptical fit are then used to generalize the seismic parameters developed in Byun (1982).

Simple numerical experiments are given to demonstrate the explorational significance of the theory. It is shown that the measurements of the normal moveout velocity are not sufficient to estimate the velocity structure of the transversely isotropic medium. The "side-slip" effect can lead to significant errors in depth-mapping dipping reflectors.

GEOPHYSICS, VOL. 49, NO. 11

0999 General (Measurements)
PERMEABILITY VERSUS DEPTH IN THE UPPER OCEANIC CRUST
R. N. Anderson (Borehole Research Group, Lamont-Doherty Geological Observatory, Columbia University, Palisades, N.Y. 10964, R. L. Newmark
M. D. Zoback (U.S.G.S., 345 Middlefield Rd.,Menlo Park, Calif. 94025), S. H. Hickman

In situ permeabilities measured within the upper kilometer of oceanic crust in Hole 504B on the south flank of the Costa Rica Rift decrease exponentially from 10^{-13} to 10^{-14} meters^2 in Layer 2A (the upper 150 meters) to 10^{-15} to 10^{-17} m^2 in Layer 2B (150-550 meters into basement) and to 10^{-17} m^2 and lower in Layer 2C (deeper than 550 meters). Extrapolation of this relationship into Layer 3 predicts permeabilities of less than 10^{-19} m^2 in the gabbroes of the lower oceanic crust (essentially impermeable). We estimate the permeability (k) versus depth (z) to vary as: $k(z) = 0.11\, e^{(z/50)} \times 10^{-12}$ m^2. If this permeability versus depth function is representative of the oceanic crust in general, then hydrothermal convection would be vertically stratified, with the most vigorous circulation confined to the shallowest pillow basalt layers of the crust. The use of a full suite of geophysical logs (including borehole televiewer imagery; multichannel, full waveform sonic; nuclear; and variable spacing electrical resistivity logs) allows the characterization of the scale and interconnectedness of fractures, and the degree of infilling of these fractures by alteration minerals. At Hole 504B, we observe a relationship between permeability and fracture porosity, determined from the geophysical logs. If fractures with similar aspect ratios are encountered at other oceanic sites, then prediction of the permeability of the oceanic crust to within an order of magnitude is possible from geophysical logs. At Hole 395A in the Atlantic, for example, *in situ* permeability measurements yielded values similar to those predicted by the logging relationships established at Hole 504B.

J. Geophys. Res., B, Paper 4B5046.

Geochemistry

1410 Chemistry of the Atmosphere
CHEMICAL PATTERNS OF ATMOSPHERIC DEPOSITION IN THE STATE OF COLORADO
William M. Lewis, Jr. (Department of Environmental, Population, and Organismic Biology, Box 334, University of Colorado, Boulder, Colorado, 80309), Michael C. Grant, and James F. Saunders, III.

Samples of bulk deposition from the atmosphere were taken over a one-year interval between May 1982 and May 1983 at 42 sites distributed over the State of Colorado. [illegible]

Water Resour. Res., Paper 4W1018.

1430 Chemistry of Meteorites and Tektites
GEOCHEMISTRY OF MUONG-NONG TYPE TEKTITES IV: SELECTED TRACE ELEMENT CORRELATIONS
C. Koeberl (Institute for Analytical Chemistry, University of Vienna, P. O. Box 73, A-1094 Vienna, Austria), F. Kluger and W. Kiesl

Muong-Nong type tektites are distinct from other tektites in their layered structure, size, petrographical characteristics, and chemistry. [illegible]

J. Geophys. Res., B, Paper 4B5002.

1490 General (Carbon Cycle)
$^{13}C/^{12}C$ RATIOS IN TREE-RINGS AND THE TRANSFER OF BIOSPHERIC CARBON TO THE ATMOSPHERE
M. Stuiver (Dept of Geological Sciences, University of Washington AJ 20, Seattle, WA 98195), R. L. Burk and P. D. Quay

Relationships between $\delta^{13}C$, ring area and ring width were investigated for 11 Pacific coastal trees. [illegible] standard deviation of 16 ppm in model calculated pre-industrial CO_2 levels. This is an upper limit for atmospheric CO_2 variability induced by changes in the size of the biospheric reservoir.

Average pre-industrial CO_2 levels are estimated to be in the 260 - 290 ppm range. The cumulative release of biospheric carbon released to the atmosphere between 1600 and 1975 is approximately 150 ± 100 gigatons C. (Carbon cycle, chemistry of the atmosphere.)

J. Geophys. Res., D, Paper 4D1177.

Geodesy and Gravity

1930 Tides
THE ROLE OF EARTH TIDES IN THE BALANCE OF TIDAL ENERGY
George W. Platzman (Department of the Geophysical Sciences, University of Chicago, Chicago IL 60637)

[illegible]

J. Geophys. Res., B, Paper 4B5129.

Geomagnetism and Paleomagnetism

2530 Spatial Variations (all harmonics and anomalies)
INTERMEDIATE WAVELENGTH MAGNETIC ANOMALIES OVER THE CENTRAL PACIFIC
J.L. LaBrecque (Lamont-Doherty Geological Observatory, Palisades, N.Y. 10964) and C.R. Cande

[illegible] satellite altitude. Other sources including the thickened crust of the oceanic plateaus and regional petrologic variations can be associated with intermediate wavelength anomalies observed in both the MAGSAT and the sea surface fields. (Magnetic anomalies, MAGSAT, Central Pacific, seamounts).

J. Geophys. Res., B, Paper 4B5035.

2530 Spatial variations (anomalies)
EXTRACTION OF MAGNETIC ANOMALIES OF CRUSTAL ORIGIN FROM MAGSAT DATA OVER THE AREA OF THE JAPANESE ISLANDS
I. Nakagawa (Earthquake Research Institute, University of Tokyo, Bunkyo-ku, Tokyo 113, Japan), Takesi Yukutake and Naoshi Fukushima

Three component data along the MAGSAT paths in the area of 110°E -170°E and 8°N -68°N were fitted by polynomial series of the coordinates of the satellite position along the path. The coefficients decrease sharply up to the 6-th degree and become almost constant. The fields represented by the 6-th degree polynomials were subtracted from the data to remove the core and the external fields. For the altitude correction a rectangular harmonic analysis was applied to the residuals thus obtained by employing local Cartesian coordinates. The residual fields were expanded into double Fourier series of the maximum order of n=m=3 over areas of 4000km square and 2000km square, and anomaly fields were computed for the satellite altitude. It was revealed that 1) an intense positive anomaly of the vertical component ran along the Kuril trench, 2) the Japan Sea was covered with a negative vertical anomaly in the northeastern part, and with a positive in the southwestern part, 3) there was a pair of positive and negative vertical anomalies covering the area from northern Korea to the East China Sea, suggesting the existence of an extremely localized magnetization like a dipole near the surface in the southwestern tip of the Korean Peninsula. (MAGSAT, magnetic anomalies, regional field)

J. Geophys. Res., B, Paper 4B1229.

2599 General (Paleomagnetism and tectonics)
PALEOMAGNETISM AND GEOLOGY OF EOCENE VOLCANIC ROCKS OF SOUTHWEST WASHINGTON, IMPLICATIONS FOR MECHANISMS OF TECTONIC ROTATION
R. E. Wells (U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025), and Robert S. Coe

Paleomagnetic and geologic investigations in Eocene volcanic rocks of the southwest Washington Coast Range demonstrate a close relationship between tectonic rotations and the local structural geology. The allochthonous middle Eocene submarine basalt basement of the Crescent Formation consists of several fault-bounded structural domains up to 30 km across that are characterized by different amounts of clockwise rotation (20° to perhaps as much as 65°) when compared to the Eocene reference pole for North America. Structural analysis shows the differential rotations post-date middle Eocene folding of the Crescent Formation against the continental margin and pre-date the unconformably overlying upper Eocene Goble Volcanics, which are rotated about 23° and do not show the same domains of rotation as the underlying Crescent Formation. Post-Goble rotations may be accommodated by a fault pattern very similar to that expected for areas caught in a simple dextral shear couple along transcurrent faults. Major north-northwest trending faults with several kilometers of dextral displacement form the boundaries of cross faulted shear domains in which the clockwise rotation of elongate crustal slices is accommodated by west-northwest trending sinistral R' Riedel shears. Thirty-five to 100 percent of the observed post-late Eocene rotations could have occurred by this shear rotation mechanism. Other paleomagnetic study areas in the Coast Range and western Cascades have a similar fault geometry and may also have undergone significant shear rotations. Long-term northward oblique subduction of the Farallon plate beneath the Coast Range throughout most of the Tertiary could have been the driving force for the shear rotations and could explain the rapid eastward decrease in rotation away from the continental margin. Shear rotations could eliminate many of the structural and stratigraphic difficulties associated with models involving rotation of large, rigid plates.

J. Geophys. Res., B, Paper 4B5008.

Hydrology

3110 Erosion and Sedimentation
MEANDERING CHANNEL RESPONSE TO ALTERED FLOW REGIME: MILK RIVER, ALBERTA AND MONTANA. C. BRADLEY AND D.G. SMITH (GEOGRAPHY DEPARTMENT, UNIVERSITY OF CALGARY, CALGARY, ALBERTA, T2N 1N4, CANADA).

Mean and peak flows, channel width and rates of meander migration are examined for two sandy meandering reaches of the Milk River in S. Alberta and N. Montana. One reach, upstream of the International boundary near Coutour, Alberta, is affected by the St. Mary diversion. The other reach near Havre, Montana, is below the Fresno Dam and reservoir.

Comparisons are possible because of the ample and long term availability of maps, air photos, and hydrometric records preceding and succeeding the two altered flows for both reaches. Understanding the natural river regime and effects of diversion and dam storage are critical for predicting channel responses to a proposed additional dam on the Milk River.

Results indicate that increased discharge due to a diversion has increased channel width 5.5 m and increased the rate of meander migration by 0.69/yr. However, reservoir storage has decreased channel width 16.5 m and channel bed degradation up to 1.5 m near the dam.

Water Resour. Res., Paper 4W1184.

3125 Glaciology
SOLUBLE IMPURITIES IN THE BYRD STATION ICE CORE, ANTARCTICA: THEIR ORIGINS AND SOURCES
Julie M. Palais (Institute of Polar Studies and Department of Geology and Mineralogy, Ohio State Univ.) and Michel Legrand (Laboratoire de Glaciologie et Géophysique de l'Environnement, Grenoble, France)

[illegible]

J. Geophys. Res., C, Paper 4C1098.

3150 Precipitation
SCALE CONSIDERATIONS IN THE MODELING OF TEMPORAL RAINFALL
I. Rodriguez-Iturbe, V. K. Gupta (Department of Civil Engineering, University of Mississippi, University, MS 38677), E. Waymire

[illegible]

Water Resour. Res., Paper 4W1101.

3160 Runoff and streamflow
A MODEL OF FLOOD WAVE SPEED-DISCHARGE CHARACTERISTICS OF RIVERS
Tony H. F. Wong and Eric M. Laurenson (Department of Civil Engineering, Monash University, Clayton, Victoria 3168, Australia)

Recent wave speed-discharge investigations carried out on six Australian river reaches show consistent variations of wave speed with discharge and present knowledge in this area with applications in both flood routing and runoff routing. A model developed to define the wave speed-discharge relation is described. The model is based on concepts of the physical factors affecting the wave speed-discharge characteristics of natural channels. It provides for overbank discharge as well as main channel flow. The applicability of the model is demonstrated using data from the six reaches. (kinematic wave speed, flood routing, flow resistance, overbank flow).

Water Resour. Res., Paper 4W1102.

3175 Soil Moisture
SOLUTE TRAVEL TIME DURING TRICKLE IRRIGATION
B.E. Clothier (Plant Physiology Div., DSIR, Palmerston North, New Zealand)

A theory of solute transport from drip (trickle) emitters is developed. The model of solute flow is based on piston-displacement, and travel times in steady, three-dimensional water flow from a surface point source. Experimental evidence is presented to justify the omission of the solute diffusion-dispersion term in the flow equation. Laboratory experiments are described to demonstrate the rapid onset of steady-state water flow, especially near the emitter. Experiments were carried out in the laboratory with bromide as a tracer in Manawatu fine sand during constant flux infiltration into a small surface cavity. The isochrones predicted from the theory were in accord with the measured bromide fronts. (3-D infiltration, quasi-linear solution, solute flow.)

Water Resour. Res., Paper 4W1207.

3180 Water quality
AN APPROACH TO MODELLING RADIONUCLIDE MIGRATION IN A MEDIUM WITH STRONGLY VARYING VELOCITY AND BLOCK SIZES ALONG THE FLOW PATH
I. Neretnieks, A. Rasmuson (Department of Chemical Engineering, Royal Institute of Technology, S-100 44 Stockholm, Sweden)

Dissolved species carried by water in fissured rock will be subject to dispersion and will diffuse in and out of the micropores of the rock matrix.

Large rock blocks will be penetrated slower than small blocks and will modify the composition of the mobile water at a different rate. To fully account for all blocksizes one partial differential equation for each block size is needed. The introduction of the PSEUDO-BODY concept reduces the modelling to one partial differential equation for all the blocks.

To account for a strongly varying velocity field a stream tube is modelled containing the various blocks. It is shown that when there is no hydrodynamic dispersion the model can be exactly transformed into one for a constant velocity flow field. Hydrodynamic dispersion can be approximately (but quite accurately) accounted for by an averaging technique. (Matrix diffusion, variable flow, dispersion, block size distribution, contaminant transport).

Water Resour. Res., Paper 4W1120.

3180 Hydrology (Water Quality)
GROUNDWATER CONTAMINATION FROM AN INACTIVE URANIUM MILL TAILINGS PILE 1. APPLICATION OF A CHEMICAL MIXING MODEL
A. F. White (Lawrence Berkeley Laboratory, Berkeley, California, 94720), J. M. Delany, T. N. Narasimhan and A. Smith

Low pH process waters contained in a number of inactive and abandoned uranium mill tailings in the United States represent potential sources of radionuclide and trace metal contamination of ground water. Detailed investigations at a typical site at Riverton, Wyoming, U.S.A. indicates chemical transport occurs from initial dewatering of the tailings, downward infiltration due to precipitation, and ground water intrusion into the base of the tailings pile. Except for elevated uranium and molybdenum concentrations, current radionuclide and trace metal transport is limited by the near-neutral pH conditions of the ground water. Significant buffering reactions include the dissolution of calcite, production of CO_2, and precipitation of gypsum and the hydroxides of iron and aluminum. A geochemical mixing model employing the PHREEQE computer code is used to estimate current rates of the ground water contamination by tailings water. A maximum mixing of 1.7 percent of pore water is a factor of two less than steady state estimates based on hydraulic parameters. (Groundwater contamination, geochemical modeling).

Water Resour. Res., Paper 4W1065.

3180 Water Quality (Solute Transport)
INTERACTIONS OF SOLUTES AND STREAMBED SEDIMENT - PART 2 - A DYNAMIC ANALYSIS OF COUPLED HYDROLOGIC AND CHEMICAL PROCESSES THAT DETERMINE SOLUTE TRANSPORT
Kenneth E. Bencala (U.S. Geological Survey, 345 Middlefield Road MS/496, Menlo Park, CA 94025)

Solute transport in streams is determined by the interaction of physical and chemical processes. Data from an injection experiment for chloride and several cations indicate significant influence of solute-streambed processes on transport in a mountain stream. These data are interpreted in terms of transient storage processes for all tracers and sorption processes for the cations. Process parameter values are estimated with simulations based on [illegible] simulations demonstrate the relative roles of the physical and chemical processes in determining solute transport. During the first twenty-four hours of the experiment, chloride concentrations were attenuated relative to expected plateau levels. Additional attenuation occurred for the sorbing cation strontium. The simulations account for these storage processes. Parameter values determined by calibration compare favorably with estimates from other studies in mountain streams. Without further calibration, the transport of potassium and lithium is adequately simulated using parameters determined in the chloride-strontium simulation and with measured cation distribution coefficients. (Streams, dead storage, kinetics)

Water Resour. Res., Paper 4W1201.

3199 Hydrology - General (Groundwater Contamination)
IMPACTS, COSTS, AND TECHNIQUES FOR MITIGATION OF CONTAMINATED GROUNDWATER: A REVIEW
Mark Sharefkin, Mordechai Shechter, and Allen V. Kneese (Resources for the Future, 1755 Massachusetts Avenue, N.W., Washington, D.C., 20036)

A framework is developed for evaluating the impacts, costs, benefits, and techniques for mitigating groundwater contamination. The framework is a generalized cost-benefit analysis. Contamination of the Cohansey aquifer in New Jersey is the subject of an illustrative case study. The plume of contamination is modelled and potential health impacts are projected based on dose-response information available from the Environmental Protection Agency. The economic value of such damages is estimated using alternative mortality risk values that span those found in the recent literature. Costs for controlling the contamination from the site are estimated for alternative levels of control and techniques of control adapting information from the EPA and other sources. While both the benefits and cost estimates should be mainly viewed as the result of illustrating a method and not as accurate estimates, they do suggest that in a case like the Cohansey, both potential damages (or damages averted, i.e., benefits) and the cost of containment once contamination has occurred can be quite high. Prevention in such cases appears to be the best cure. The paper closes with a discussion of the potential role of economic incentives in the generation of hazardous wastes and their "safe" disposal. (Groundwater, contamination, benefits, costs, incentives).

Water Resour. Res., Paper 4W1167.

Meteorology

3705 Air Quality
BIOGENIC HYDROCARBON EMISSIONS FROM DECIDUOUS AND CONIFEROUS TREES IN THE U.S.
B. Lamb (Laboratory for Atmospheric Research, College of Engineering, Washington State University, Pullman, Washington, 99164-2730), H. Westberg, G. Allwine and T. Quarles

Measurements of natural hydrocarbon emission fluxes are reported for a northeastern U.S. deciduous forest, a northwestern U.S. coniferous forest and for dominant tree species in the Atlanta, GA region. The emission data were obtained using a vegetation enclosure procedure and a micrometeorological gradient technique. Isoprene fluxes determined by the gradient method in the deciduous forest varied from 2,500 µg/m²-hr at 20°C to 8,000 µg/m²-hr at 30°C. Corresponding fluxes obtained with the vegetation enclosure method ranged from 690 to 7,300 µg/m²-hr. Isoprene fluxes determined by both methods increased exponentially with increasing temperature. Emission rates from isoprene emitting trees in the Atlanta area were similar to those observed in Pennsylvania. Alpha-pinene fluxes measured in a Douglas fir forest ranged from 9 to 1,120 µg/m²-hr. Relative humidity appeared to directly influence the alpha-pinene emission rate. The reasonable agreement between hydrocarbon fluxes obtained with two independent techniques is significant evidence of the general validity of current biogenic hydrocarbon emission rates. (Biogenic hydrocarbons, isoprene, alpha-pinene).

J. Geophys. Res., D, Paper 4D1232.

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3725 Convection, turbulence, and diffusion
CONCURRENT MEASUREMENTS OF OZONE DRY DEPOSITION USING EDDY CORRELATION AND PROFILE FLUX METHODS
J. G. Droppo (Geosciences Research and Engineering Department, Battelle Pacific Northwest Laboratories, Richland, Washington, 99352)
Simultaneous surface-layer ozone flux measurements by eddy flux and profile methods are reported with supporting micrometeorological data. The results show a close correspondence between the eddy diffusivities of ozone and sensible heat rather than momentum heat eddy diffusivity. Ozone deposition velocities are computed both from the eddy and profile fluxes of ozone. As with eddy diffusivities, these results clearly show the sensible heat analogy giving the better fit with the eddy flux values. Three sets of deposition velocities also have a consistent temporal variation, with peak values of up to 1 cm/s at midday changing to less than 0.1 cm/s in the evening. (Dry Deposition, Ozone, Eddy Diffusivity).
J. Geophys. Res., D, Paper 4D1163.

3735 Electrical Phenomena (Meteorology)
THE ELECTRIC FIELD SPECTRA OF LIGHTNING RETURN STROKES: CORRECTION TO SERHAN ET AL. (1980)
J. Frain (Department of Electrical Engineering, University of Florida, Gainesville, FL 32611), M.A. Uman and B.G. Childers
Corrections are given to the electric-field frequency spectra for lightning return strokes published by Serhan et al. (1980). Their spectra for lightning within 12 km are in error primarily due to rectangular windowing of measured time-domain waveforms having non-zero values at the end of the windowing period but additionally due to errors associated with using the FFM method to extend the lower end of the frequency range. The corrected spectra are obtained from model electric-field waveforms derived from typical measured waveforms observed at various distances over both land and salt water.
Rad. Sci., Paper 4S1226.

Mineralogy, Petrology, and Crystal Chemistry

4230 Experimental mineralogy and petrology
SIDERITE DIGESTION IN LARGE MAGMA BODIES
David Walker (Lamont-Doherty Geological Observatory and Department of Geological Sciences, Columbia University, Palisades, New York 10964), Walter S. Kiefer
Xenolith digestion during sinking in a convecting magma is treated with a [illegible] relation suggested from experiments on silicate crystals. The relation is shown to apply to a wide range of dynamical regimes from analog experiments on KCl dissolution in water. Using this relation, xenolith penetration by sinking into magmas is shown to be strongly dependent on xenolith size. Crystal sinking is unimportant but sinking of water-rich chunks can be a major process of mass and heat transport in planetary-scale magma body evolution. This evolution cannot be adequately treated with current information.
J. Geophys. Res., B, Paper 4B5559.

4299 General (Petrography and Petrology)
PETROLOGY OF APOLLO 11 REGOLITH BRECCIAS
S.B. Simon (Institute for the Study of Mineral Deposits, South Dakota School of Mines and Technology, Rapid City, South Dakota 57701), J.J. Papike, and C.K. Shearer
Petrographic and mineral chemical data for sixteen Apollo 11 regolith breccias show that (1) the regolith breccias differ from soil 10084 with respect to a) agglutinate content; b) glass population; c) plagioclase compositions, and d) proportions of high-K mare and low-K mare basalt components; (2) the A-11 breccias and soil have highland components that are similar both in abundance and petrology, and (3) lunar regolith breccias provide a better comparison with howardites than do lunar soils. The data and observations are consistent with formation of the regolith breccias from immature soil. It appears that little or no highland material has been added to the Tranquillitatis regolith since the formation of the breccias. (Apollo 11, regolith, regolith breccias, petrology).
J. Geophys. Res., B, Paper 4B5807.

Oceanography

4505 Boundary layer and exchange processes
SIMULATION OF THE MIXED LAYER AT OWS NOVEMBER AND PAPA WITH SEVERAL MODELS
P. J. Martin (Naval Ocean Research and Development Activity, NSTL Station, Mississippi 39529)
The Mellor-Yamada Level 2 and 2 1/2, Niiler, and Garwood one-dimensional mixed-layer models were compared for some simple forcing experiments, and tested by simulating changes in the mixed layer at Ocean Stations November and Papa for the year 1961. The ocean station simulations show that the models can be tuned to give fairly good results. However, the need to readjust model constants when changing locations suggests that there is room for improving some of the mixing parameterizations.
The sensitivity of the model simulations to certain "external" parameterizations including surface heat flux, seawater turbidity, and ambient diffusivity below the mixed layer was investigated. The year-long simulations were found to be very sensitive to the seawater turbidity. Increasing the turbidity from Jerlov Optical Type I to Type III causes a maximum increase in the monthly mean SST at November of 3°C or more. The simulations are not sensitive to seawater turbidity during summer when the mixed layer remains shallow. Increasing the ambient diffusivity, a decrease from 0.4 to 0.01 cm^2/s results in a maximum increase in the monthly mean SST at November and Papa of 0.5 and 1.5°C respectively. The effects of using a constant ambient diffusivity are most noticeable in late summer when the seasonal thermocline is strongest. The effects are larger at Papa than November because of the stronger summer seasonal thermocline at Papa. Best results at November and Papa were obtained using the observed Optical Water Types II and III, respectively, and relatively small values for ambient diffusivity (less than 0.2 cm^2/s). (diffusion, mixed layer, turbulent mixing).
J. Geophys. Res., C, Paper 4C1073.

4750 Chemical Oceanography
SHORT-TERM TEMPORAL VARIABILITY OF EOLIAN PARTICLES IN SURFACE WATERS OF THE NORTHWESTERN NORTH PACIFIC
M. Uematsu (Center for Atmospheric Chemistry Studies, Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island 02881), R.A. Duce, J. Nakaya and S. Tsunogai
The concentrations of particulate Al and total suspended particulate matter (TSP) were measured in surface waters at 42 stations on a cruise from Tokyo to Alaska and return during the summer of 1978. The mean particulate Al concentration in early July (5.5 µg kg^{-1}) was almost eight times higher than in mid-August (0.72 µg kg^{-1}). However, the mean TSP concentration was only twice as high. The high particulate Al concentration in the surface waters in July was correlated with high atmospheric dust concentrations over this area, and this was likely transported from the desert regions of central and eastern Asia. The atmospheric mineral matter deposited on the ocean surface was rapidly removed to deeper waters within one month. The temporal variability of atmospheric concentrations and deposition of mineral matter may significantly affect the distributions and fluxes of this material in the oceanic water column of the North Pacific. (particulate Al, total suspended particulate matter, mineral particles, atmospheric dust input).
J. Geophys. Res., C, Paper 4C1123.

4760 Sea Ice
ICE THICKNESS DISTRIBUTION IN DAVIS STRAIT IN FEBRUARY FROM SUBMARINE SONAR PROFILES
Peter Wadhams (Scott Polar Research Institute, University of Cambridge, Cambridge CB2 1ER, England), Alfred S. McLaren and Ruth Weintraub
A submarine sonar profile obtained in Davis Strait by USS Queenfish in February 1967 has yielded the first quantitative data on ice thickness distribution in this region. Within 50 - 100 km of the ice edge there is a "marginal ice zone" (MIZ) where the mean draft is 0.75 - 0.53 m, most of the ice (93 - 100%) is undeformed and there are many leads but few ridges, all of them less than 6.1 m in draft. The remainder of the region is an "interior zone" composed mainly of first-year ice, with a mean draft of 0.77 - 1.66 m increasing slightly from NE to SW. Level ice is less common than in the MIZ (67 - 91% of the cover) [illegible]. Ridging is more common, with a maximum observed keel draft of 19.56 m. The overall mean ice thickness distribution has a peak at a draft of 1.05 m (1.18 m thickness), identified as the preferred draft of undeformed first-year ice at this time. Ice draft and keel draft distributions followed a negative exponential distribution at depths beyond 3 - 4 m, and the distribution of level widths followed a power law with exponent -2.29.
J. Geophys. Res., C, Paper 4C1174.

4760 Sea Ice
AN ALGORITHM TO MEASURE SEA ICE CONCENTRATION WITH MICROWAVE RADIOMETERS
C. T. Swift (Department of Electrical and Computer Engineering, University of Massachusetts, Amherst, MA, 01003), L. S. Fedor, R. O. Ramseier
An algorithm is developed which uses two microwave radiometer channels to estimate quantities of first-year and multi-year sea ice. The algorithm is applied to data obtained from satellite sensors, and the data are used to refine values of the emissivities. The algorithm was tested and results were in reasonable agreement with visual observations, where mixtures of first-year sea ice and multi-year sea ice were known to co-exist. However, on a synoptic basis, the satellite estimates differ from visual and radar means of classifying ice that has survived at least one melt season (old ice). A possible explanation for the discrepancy is that the emissivity of sea ice changes over time periods longer than one melt season. (Sea ice, microwave remote sensing).
J. Geophys. Res., C, Paper 4C1270.

4760 Sea Ice
SEA ICE MOTION AS A DRUNKARD'S WALK
R. Colony (University of Washington, Polar Science Center, 4057 Roosevelt Way NE, Seattle, WA 98105), A. S. Thorndike
Observations of sea ice displacement over short periods of time are used to deduce some statistics of the ice motion over long periods of time. The objective is to follow the trajectory of a piece of ice starting at a randomly selected time and location, and ending when the ice either melts or leaves the Arctic Basin. Trajectories are also followed backward in time to the time and location where the piece of ice was formed. Statistical properties considered are the age and remaining life time of ice in various locations, and the probability that ice presently occupying a particular location was originally created or will ultimately melt in certain regions. Possible applications are to the distribution of pollutants by sea ice and to the design of experiments involving drifting measurement platforms. (sea ice motion, drifting buoys)
J. Geophys. Res., C, Paper 4C1255.

4760 Sea Ice
LINEAR PREDICTION OF SEA ICE ANOMALIES
C. H. Johnson (Max-Planck-Institut für Meteorologie, Bundesstr. 55, 2000 Hamburg 13, FRG), P. Lemke and T. P. Barnett
Stationary and cyclostationary statistical models are developed to predict Arctic and Antarctic sea ice anomalies using as predictors previous sea ice, atmospheric and oceanic anomalies. A prediction model hierarchy is developed using first internal (i.e., sea ice) predictors including persistence, lateral advection and diffusion, and a cyclostationary model that allows the prediction coefficients to vary seasonally. An external cyclostationary model hierarchy is developed next to investigate the ability of atmospheric winds, heat flux proxies, air temperatures and sea surface temperatures to predict sea ice extent.
In the Arctic the highest skill was generally achieved by the cyclostationary internal model. Attempts to forecast the ice data at 1-2 month interval after removal of its autoregressive component, using external predictors, gave non-significant models. At longer lead times (e.g., three-months) the SST in the North Pacific was superior to persistence for sea ice prediction in the western Bering Sea. In the Southern ocean, especially off East Antarctica, the model that included lateral advection and diffusion outperformed both persistence and the cyclostationary internal model. In the Weddell Sea and the Ross Sea persistence proved to be the best sea ice predictor. No external models were tested for Antarctic sea ice due to insufficient data.
J. Geophys. Res., D, Paper 4D1194.

4755 Surface Waves, Tides, and Sea Level
SET-UP AND SWASH ON A NATURAL BEACH
R. A. Holman (College of Oceanography, Oregon State University, Corvallis, Oregon, 97331) and A. H. Sallenger
Wave set-up and swash statistics were calculated from 154 runup time series measured on a moderately steep beach under incident waves varying from 0.4 to 4.0 m significant wave height. When scaled by the incident wave height, set-up, swash height, and total runup (the sum of set-up and half the swash height) were found to vary linearly with the surf zone similarity parameter, $\xi_0 = \beta(H_0/L_0)^{-1/2}$. The foreshore slope appeared the appropriate value for the calculation of ξ_0, although the set-up data showed some influence of an offshore bar at low tide. For low Iribarren numbers the swash height in the incident frequency band was dependent on tidal stage. For Iribarren numbers no such signs of saturation were seen. Thus the infragravity band appears to become dominant in the swash below some value of ξ_0. For these data, that value is approximately 1.75, although there is considerable scatter associated with that estimate. (Set-up, run-up, infragravity).
J. Geophys. Res., C, Paper 4C1258.

4770 Turbulence and diffusion
ICE INDUCED VERTICAL CIRCULATION IN AN ARCTIC FJORD
Edward P.W. Horne (Marine Ecology Lab, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, N.S., Canada, B2Y 4A2)
CTD and nutrient data taken in South Cape Fiord near the ice-front show evidence of upwelling. In addition a region of downwelling is found from 0.5 km to 5 km from the ice. Intruding layers with thicknesses consistent with ice measurements are found near the ice. A phytoplankton bloom is found to be going on in the fjord and an upwelling velocity of 2×10^{-5} ms^{-1} is calculated by assuming that all the nitrogen required by these cells is upwelled from the deep water within 35 m of the glacier. Mechanisms to drive the downwelling are discussed. (upwelling, ice, downwelling, double diffusion).
J. Geophys. Res., C, Paper 4C1203.

Particles and Fields— Interplanetary Space

5340 Shock waves
DOPPLER SCINTILLATION OBSERVATIONS OF INTERPLANETARY SHOCK WAVES WITHIN 0.3 AU
R. Woo (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109), J.W. Armstrong, N.R. Sheeley, Jr., R.A. Howard, M.J. Koomen, D.J. Michels and R. Schwenn
Near-sun spacecraft Doppler scintillation observations have been combined with Solwind coronagraph and Helios 1 plasma measurements to provide more definitive measurements of the evolution and propagation of interplanetary shock waves between the sun and earth than have been available from previous observations. This study shows that substantial deceleration of fast shocks (shock speeds exceeding 1000 km s^{-1}) takes place near the sun, and that the amount of deceleration increases with shock speed. This is consistent with the significantly lower and rather narrow range of shock velocities observed by direct spacecraft near earth orbit. When coronal mass ejection (CME) speeds are available for the fast shocks, they are considerably lower than the speeds measured farther out but near the sun. This implies that, either the fast shocks first accelerate before decelerating on their way out from the sun (assuming the CME front is identified with the shock), or the CME speeds do not represent and substantially underestimate the shock speeds in the outer corona. If the CME speed underestimates the shock speed of the fast shocks, they do not appear to do so for the slow shocks. If the shocks are being driven over distances indicated by the acceleration region to the point where deceleration begins, then their velocity profiles imply that the slower shocks are being driven farther out than the faster shocks. The analysis of one piston-driven shock shows that the velocity of the contact surface is about 0.58 that of the shock front velocity. (Radio scintillations, white-light coronagraph, Helios)
J. Geophys. Res., A, Paper 4A8152.

5340 Shock Waves
CORONAL MASS EJECTIONS AND INTERPLANETARY SHOCKS
N. R. Sheeley, Jr., R. A. Howard, M. J. Koomen, D. J. Michels (E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, DC 20375) and R. Schwenn, K. H. Mühlhäuser, H. Rosenbauer (Max Planck Institut für Aeronomie)
A comparison between SOLWIND observations of coronal mass ejections (CMEs) and HELIOS 1 observations of interplanetary shocks during 1979-1982 indicates that 72% of the shocks were associated with large low-latitude mass ejections on the nearby limb. Most of the associated CMEs had speeds in excess of 500 km/sec, but some of them had speeds in the range 200-400 km/sec. An additional 26% of the shocks may have been associated with CMEs, but we were less confident of these associations because the sizes and locations of the CMEs did not seem appropriately different from those of the numerous CMEs without HELIOS shocks. Only 2% of the shocks clearly lacked CMEs. As the average level of sunspot activity declined during 1982, the shock frequency also declined, but the observed shocks and some of their associated CMEs had unusually high speeds well in excess of 1000 km/sec. (Coronal mass ejections, HELIOS shocks).
J. Geophys. Res., A, Paper 4A8100.

5340 Shock waves
OBSERVATIONS OF 3-DIMENSIONAL ANISOTROPIES OF 35-1000 KEV PROTONS ASSOCIATED WITH INTERPLANETARY SHOCKS
T.R. Sanderson (Space Science Department of ESA, ESTEC Noordwijk, The Netherlands), R. Reinhard, P. van Nes and K.-P. Wenzel
We present results of a statistical analysis of 3-dimensional anisotropies of protons in the energy range 35-1000 keV observed in association with interplanetary shocks on ISEE-3. We compare our observations with theoretical predictions for Fermi acceleration and shock drift acceleration, and find good evidence for both types of acceleration. We observe a small number of events exhibiting the signature of Fermi acceleration, and a somewhat larger number exhibiting the signature of shock drift acceleration, the Fermi events being associated with quasi-parallel shocks and the shock-drift events being associated with quasi-perpendicular events. We find that the Fermi mechanism is capable of accelerating protons in the energy range 35-1000 keV out of the thermal distribution [illegible]. In addition, the existence of large fluxes of solar flare particles with energies greater than a few hundred keV appears to be an important requisite for the Fermi mechanism.
J. Geophys. Res., A, Paper 4A8158.

5340 (Shock Waves)
NONLINEAR EVOLUTION OF SLOW WAVES IN THE SOLAR WIND
T. Hada and C. F. Kennel (Department of Physics and Institute of Geophysics and Planetary Physics, U. C. L. A., Los Angeles, CA)
Recent discoveries of slow mode interplanetary shocks by Helios within 0.3 AU of the sun have greatly increased space physical interest in all aspects of slow mode waves and shocks. This paper is concerned with defining when slow waves should steepen. We discuss the time evolution of nonlinear slow and fast waves in a kinetic description. To map out the problem, we first compare the characteristic time scales for nonlinear wave steepening, derived from fluid theory, and linear damping, derived from kinetic theory. Only if the linear damping time exceeds the steepening time do we expect nonlinear periodic waves and pulses to steepen. We show that this simple criterion defines the parameters for which slow waves [illegible] steepen by numerically simulating the time evolution of such waves using a hybrid code with fluid electrons and super-particle ions.
J. Geophys. Res., A, Paper 4A8286.

5380 Solar wind plasma
LARGE AMPLITUDE MHD WAVES UPSTREAM OF THE JOVIAN BOW SHOCK: REINTERPRETATION
M. L. Goldstein (Laboratory for Extraterrestrial Physics, NASA Goddard Space Flight Center, Greenbelt, MD 20771), H. K. Wong, and A. F. Viñas, C. W. Smith
Observations of large amplitude MHD waves upstream of the Jovian bow shock have previously been interpreted as arising from a resonant electromagnetic ion beam instability. That interpretation was based on the conclusion that the observed fluctuations were predominantly right elliptically polarized in the solar wind rest frame. Because it has been noted by the authors that the fluctuations are, in fact, left-elliptically polarized, a reanalysis of the observations is necessary. We investigate several mechanisms for producing left hand polarized MHD waves in the observed frequency range. Instabilities excited by protons appear unlikely to account for the observations. A resonant instability excited by relativistic electrons streaming along the magnetic field away from Jupiter is a likely source of free energy consistent with the observations. Evidence for the existence of such a population of electrons has been found in both the Low Energy Charged Particle experiments and Cosmic Ray experiments on Voyager 2. This new interpretation is reminiscent of earlier observations, using Pioneer data, of left polarized (solar wind frame) MHD fluctuations in association with relativistic electrons.
J. Geophys. Res., A, Paper 4A8259.

Particles and Fields— Ionosphere

5515 Auroras
RADAR AND PHOTOMETRIC MEASUREMENTS OF AN INTENSE TYPE A RED AURORA
R. M. Robinson, S. B. Mende, R. R. Vondrak, (Lockheed Palo Alto Research Laboratory, Palo Alto, CA 94304), J. C. Foster [illegible] (University of Michigan, Space Physics Research Laboratory, Ann Arbor, MI 48109)
On the evening of 5 March 1981, an intense, type A red aurora appeared over southern Alaska. Radar and photometric measurements were made of the aurora from the Chatanika radar site. The line-of-sight intensity of 630.0 nm emissions exceeded 150 kR and was accompanied by enhanced emissions at 486.1 and 427.8 nm. The Chatanika radar measured electron densities of 10^6 cm^{-3} and electron temperatures of over 4000 K at altitudes of 300 km and above [illegible] invariant latitudes of 59° in association with the aurora. Comparison of optical and radar measurements indicated that the 630.0 nm emissions were produced to a large degree by thermal excitation of O(^{1}D) at the high electron temperatures and densities. Model calculations indicate that the observed density and temperature enhancements and the related optical emissions were the results of a relatively short duration (5-10 min) pulse of precipitating, low-energy (~30 eV) electrons. [illegible] (Type A aurora, electron temperature, storm effects)
J. Geophys. Res., A, Paper 4A8175.

5520 Electric Fields
A COMPARISON OF IONOSPHERIC ELECTRIC FIELDS INFERRED FROM STARE DRIFT DATA AND FROM GLOBAL IMS MAGNETOMETER DATA
K. B. Baker (Applied Physics Laboratory, Johns Hopkins University, Laurel, Maryland 20707), Y. Kamide (Kyoto Sangyo University, Kamigamo, Kita-ku, Kyoto 603, Japan)
For the two CDAW 6 periods, March 22, and March 31 - April 1, 1979, Kamide et al. have used global IMS magnetometer data along with the Rice ionospheric conductivity model to estimate the electric fields and currents at high latitudes. A check on this procedure can be obtained by comparing these results with the electric fields inferred from the drift velocities measured by the STARE radars. We find that in general the two methods agree to within 20% confirming the utility of the IMS magnetometer data in estimating the global electric field distribution. However, systematic differences in the two methods suggest that modifications must be made in the statistical conductivity model when applying it to dynamical processes.
J. Geophys. Res., A, Paper 4A8034.

5530 High-latitude ionospheric currents
ANTI-SUNWARD SPACE CURRENT BELOW THE MAGSAT LEVEL DURING MAGNETIC STORMS, AND ITS POSSIBLE CONNECTION WITH PARTIAL RING CURRENT IN THE MAGNETOSPHERE
A. Suzuki, M. Yanagisawa and N. Fukushima (Geophysics Research Laboratory, University of Tokyo, Tokyo 113, Japan)
It is possible to calculate, with the MAGSAT data, the total amount of electric current passing through the plane enclosed by the MAGSAT orbit, from the line-integration of the observed magnetic field component tangential to the MAGSAT orbit, i.e. a direct application of Ampère's theorem. After eliminating the spurious effect arising from the earth's rotation under the MAGSAT orbit, it is concluded that the space current of a few million A flows anti-sunward below the MAGSAT level during magnetic storms, whereas such a space current is almost absent on quiet condition. The depression in the horizontal intensity of geomagnetic field in low latitudes is noticeably greater on the dusk side than on the dawn side, especially at the developing stages of magnetic storms. Combining these two observations, we may conclude that 10-20% of the westward ring (or shell) current in the dusk magnetosphere will close its current circuit with anti-sunward field-aligned current in the magnetosphere connected with a net horizontal current flowing in the ionosphere. (Field-aligned current, partial ring current, magnetic storm, MAGSAT)
J. Geophys. Res., A, Paper 4A1206.

5563 Plasma motion, convection or circulation
ELECTRICAL COUPLING EFFECTS ON THE TEMPORAL EVOLUTION OF F-LAYER PLASMA STRUCTURE
R. A. Heelis (Physics, Space Sci., Univ. of Texas at Dallas, Richardson, TX 75083), J. F. Vickrey and N. B. Walker
A time-dependent model of F-region structure decay by "classical" cross field diffusion and electrical coupling along magnetic field lines to the E-region is examined. The temporal behavior of the ion concentration fluctuations is determined by the electric field in the coupled system as well as by the initial perturbation spectra and the E-region recombination rate. The formation of image structure in the E-region ion concentration affects the lifetime of F-layer structure in a scale size dependent way. Once an image is formed, the image amplitude and the driving F-region structure amplitude decay at the same rate. At large scale sizes, $\lambda(\lambda = 2\pi/k)$, this rate is proportional to k^2 and the ratio of the temperatures in each region. At small scale sizes it depends on the E-region recombination rate and the temperatures of the two regions but is only very weakly dependent on k. The background E-region concentration determines the wave number beyond which the structure amplitude decay rate is almost independent of its scale size.
J. Geophys. Res., A, Paper 4A8183.

5580 Wave propagation (Echoes)
LONG-DELAYED RADIO ECHOES: MECHANISMS AND OBSERVATIONS
R. Vidmar (SRI International, Menlo Park, CA 94025) and F. W. Crawford
Experiments carried out in Alaska with the object of observing long-delayed radio echoes (LDEs) are described. The results are subjected to critical sonagram analysis, together with data from previous experiments carried out at Stanford and elsewhere. It is concluded that, although strong supporting evidence for sporadic LDE phenomena has accumulated over the last 50 years, and a variety of plausible mechanisms have been proposed, stringent analysis of records such as those discussed in the paper almost invariably reveals alternative possible explanations for them. Further detailed experimentation is required on mechanisms, for which the phenomenon seems best established, e.g., round-the-world echoes and other forms of guided propagation. (Ionosphere, sonagrams, LDE)
J. Geophys. Res., A, Paper 4A1256.

Particles and Fields— Magnetosphere

5705 Bow Shock Waves
ANISOTROPY OBSERVATION OF DIFFUSE IONS (> 30 keV/e) UPSTREAM OF THE EARTH'S BOW SHOCK
T. Terasawa (Inst. of Space and Astronautical Science, Meguro-ku, Tokyo, Japan), M. Scholer and F.M. Ipavich
We have performed a detailed study of the temporal development of field-aligned anisotropies and density gradient anisotropies during several diffuse ion events observed upstream of the earth's bow shock. A clear anticorrelation between the field-aligned anisotropy and the particle intensity is found; in the solar wind frame this anisotropy, which is directed away from the bow shock, decreases as the particle flux increases. Furthermore, the field-aligned anisotropy increases with increasing particle energy. In the strong scattering limit the one-dimensional diffusion-convection formalism predicts a decrease of the anisotropy with increasing energy. It is concluded that upstream escape is significant for higher energy particles and leads to the deviation from the prediction of the diffusion-convection formalism. Quantitatively, the diffusion-convection formalism predicts a field-aligned anisotropy which is larger than measured for the lowest energy particles (~30 keV/e). Along with the variation of the field-aligned anisotropy, the appearance of a density gradient anisotropy was also observed. The observations are discussed in terms of a first order Fermi model for the upstream particles and in terms of a magnetospheric origin. It is concluded that field-aligned anisotropy measurements obtained upstream of the bow shock cannot help to differentiate between the two possible models for the upstream population. (Upstream particles, diffuse ions, anisotropies).
J. Geophys. Res., A, Paper 4A1263.

5705 Bow shock waves
THE PROPAGATION AND GROWTH OF WHISTLER MODE WAVES GENERATED BY ELECTRON BEAMS IN EARTH'S BOW SHOCK
Robert L. Tokar (Earth and Space Science Division, Los Alamos National Laboratory, Los Alamos, NM 87545) and Donald A. Gurnett
In this study, the propagation and growth of whistler mode waves generated by electron beams within Earth's bow shock is investigated using a planar model for the bow shock and a model electron distribution function. Within the shock, the model electron distribution function possesses a field-aligned $T_\parallel > T_\perp$ beam that is directed toward the magnetosheath. Waves with frequencies between about 1 and 100 Hz with a wide range of wave normal angles are generated by the beam via Landau and anomalous cyclotron resonances. However, because the growth rate is small and because the wave packets traverse the shock quickly, these waves do not attain large amplitudes. Waves with frequencies between about 30 and 150 Hz with a wide range of wave normal angles are generated by the beam via the normal cyclotron resonance. The ray paths for most of these waves are directed toward the solar wind although some wave packets, due to plasma convection, travel transverse to the shock normal. These wave packets grow to large amplitudes because they spend a long time in the growth region. The results suggest that whistler mode noise within the shock should increase in amplitude with increasing upstream Vge. The study provides an explanation for the origin of much of the whistler mode turbulence observed at the bow shock. (Bow shock, whistler mode noise).
J. Geophys. Res., A, Paper 4A8102.

5720 Interactions between solar wind and magnetosphere
DYNAMICS OF INTENSE UPSTREAM ION EVENTS
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We study temporal structures, energy spectra, and spatial gradients of 25-70 keV protons during four intense upstream ion events observed on December 3,1977, by the medium energy particle telescope (KED) on ISEE-2. The strong role of the bow shock connection time in controlling the absolute intensity and spectral shape of the upstream ions is confirmed. The path along which the convected magnetic field is carried on the bow shock surface has no observable influence. During the plateau phases we determine a field-aligned gradient with an e-folding distance L = 6.5 ± 1.5 R_E for ≈30 keV protons. The combination with anisotropy data leads to a direct determination of the mean free path $\lambda_\parallel$ = 2.6 ± 0.6 R_E. A perpendicular gradient points towards the nose of the bow shock with a north-south component of about 6 %/R_E. Its conversion to a spatial scale allows to estimate the perpendicular diffusion coefficient. We conclude that lateral diffusion is not the main escape mechanism which determines the exponential energy spectrum. The control of the acceleration efficiency by local characteristics of the bow shock is suggested by various observations: (i) fluctuations on a temporal scale of about 20 minutes with an amplitude of about 50 % superimposed on the plateau phases; (ii) structured onsets of events during smoothly improving connection conditions; (iii) strong intensity modulation during marginal acceleration conditions; (iv) convection of differently populated field lines across the observer. We tentatively relate the variable acceleration efficiency to changes in the angle between the shock normal and the local magnetic field direction. (Shock acceleration, diffusion coefficient, particle measurements).
J. Geophys. Res., A, Paper 4A1213.

5720 Interactions between solar wind and magnetosphere
DAYSIDE MAGNETOPAUSE RECONNECTION
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The Petschek model of magnetic field line reconnection is generalized for magnetopause-like conditions to enable a comparison of data and theory. The two-dimensional, compressible MHD model considered, reveals four discontinuities which are necessary to match the different magnetic fields and plasma parameters inside and outside the magnetopause. The magnetosheath plasma is accelerated and deflected by a large amplitude Alfvén (rotational) wave and either a slow shock or a slow rarefaction wave (slow expansion fan). Another slow shock focuses the plasma flow from the magnetospheric side. A contact discontinuity inside the boundary layer separates the plasma flows from magnetosheath and magnetosphere. Using realistic magnetopause parameters the results are illustrated by numerical examples and discussed in connection with geophysical observations. (Field Line Reconnection, Magnetopause).
J. Geophys. Res., A, Paper 4A8014.

5737 (Magnetic Storms)
DYNAMICS OF THE 1054 UT MARCH 22, 1979, SUBSTORM EVENT CDAW-6
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The physical processes involved in the transfer of energy from the solar wind to the magnetosphere, and release associated with substorms, have been examined in a sequence of Coordinated Data Analysis Workshops (CDAW-6). Magnetic storms of March 22 and 31, 1979 were chosen to study the problem, using a data base from 13 spacecraft and about 130 ground-based magnetometers. This paper describes the March 22 storm, in particular the large, isolated substorm at 1054 UT which followed an interval of magnetic calm. We summarize the observations in the solar wind, in various regions of the magnetosphere, and at the ground, synthesizing these observations into a description of the substorm development.
We then give our interpretation of these observations and test their consistency with the reconnection model. The substorm appears to have been generated by a southward turning of the interplanetary magnetic field associated with a current sheet crossing. Models of ionospheric currents derived from ground data show the substorm had three phases of development. During the first phase, a two-celled convection current system developed in the polar cap as synchronous spacecraft on the night side recorded increasingly tail-like field and the ISEE measurements show that the near-earth plasma sheet thinned. In the second phase, possibly triggered by sudden changes in the solar wind, a one-celled current system was added to the first, enhancing the westward electrojet. During this phase the synchronous field became more dipolar and the plasma sheet magnetic field turned strongly southward as rapid tailward flow developed soon after expansion onset, suggesting that a neutral line formed in the near-Earth plasma sheet with subsequent plasmoid ejection. In the third phase, which occurred after the IMF turned northward, the magnetospheric current systems decayed as the plasma sheet expanded and the flow turned earthward. The data from this event support the notion that substorms include two major processes of energy dissipation: one directly driven by the solar wind and one driven by release of energy stored in the geomagnetic tail. The near-tail data suggest that one or more neutral lines formed earthward of the ISEE spacecraft. However, all the signatures of plasma flow and energetic particles can be explained only by postulating a complex series of events. While this reconnection picture represents the interpretations of many of the CDAW-6 participants, it is not a consensus viewpoint. (Substorms, CDAW, reconnection, energy transfer)
J. Geophys. Res., A, Paper 4A8273.

5742 Magnetosheath
SHORT WAVELENGTH ELECTROSTATIC WAVES IN THE EARTH'S MAGNETOSHEATH
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Recent observations with the ISEE-1 spacecraft have found electric field emission in the dayside magnetosheath whose frequency spectrum is modulated at twice the spacecraft spin period. The upper frequency cutoff in the frequency-time spectrum of the emission has a characteristic parabola shape or "festoon" shape. The low frequency cutoff ranges from 100 Hz to 400 Hz, while the high frequency limit ranges from about 1 kHz to 4 kHz. The bandwidth is found to minimize for antenna orientations parallel to the wave vectors. The wave vector does not appear to be related to the local magnetic field, the plasma flow velocity, or the spacecraft-sun directions. The spacecraft observed frequency spectrum results from the spacecraft antenna response to the Doppler shifted wave vector spectrum which exists in the plasma. Imposed constraints on the plasma rest-frame wave vectors and frequencies indicate that emissions occur within the frequency range from about 150 Hz to 1 kHz, with wavelengths between about 40 meters and 600 meters. These constraints strongly suggest that the festoon-shaped emissions are ion-acoustic waves. The small group velocity and $\vec{E}$ direction of the ion-acoustic mode are consistent with wave generation upstream at the bow shock and convection downstream to locations within the outer dayside magnetosheath.
J. Geophys. Res., A, Paper 4A1242.

5745 Magnetospheric configuration
NEAR EQUALITY OF ION PHASE SPACE DENSITIES AT EARTH, JUPITER AND SATURN
A. F. Cheng (Johns Hopkins University, Applied Physics Laboratory, Laurel, Maryland 20707), S. M. Krimigis and T. P. Armstrong
Energetic ion phase space density profiles are strikingly similar in the inner magnetospheres of Earth, Jupiter, and Saturn for ions of first adiabatic invariant not near 100 MeV G^{-1} and small mirror latitudes. Losses occur inside L ~ 7 for Jupiter and Saturn and inside L ~ 5 at Earth. At these L values there exist steep plasma density gradients at all three planets, associated with the Io plasma torus at Jupiter, the Rhea-Dione-Tethys torus at Saturn, and the plasmasphere at Earth. Measurements of ion flux tube contents at Jupiter and Saturn by the Low Energy Charged Particle (LECP) experiment show that these are similar (for oxygen ions 5 ≤ L ≤ 9) to those at Earth (protons 2 ≤ L ≤ 6). Furthermore, the thermal ion flux tube contents from Voyager Plasma Science (PLS) data at Jupiter and Saturn are also very nearly equal, and again similar to those at Earth, differing by less than a factor of three at the respective L values. The near equality of energetic and thermal ion flux tube contents at Earth, Jupiter, and Saturn suggests the possibility of strong physical analogies in the interaction between plasma and energetic particles at the tori/plasma sheets of Jupiter and Saturn and the plasmasphere of the Earth. (Ion phase space densities, plasma sheets, plasma tori, radiation belts).
J. Geophys. Res., A, Paper 4A8191.

5755 Plasma instabilities
ION CYCLOTRON WAVES BELOW THE PROTON GYROFREQUENCY IN THE MAGNETOSPHERE
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A numerical comparison between the linear theory of ion cyclotron waves below the proton gyrofrequency and the data recorded on board of the GEOS satellites, is made. It is shown that the experimental data are in good agreement with the theory
J. Geophys. Res., A, Paper 4A1144.

5755 Particles and Field-Magnetosphere (Plasma Instabilities)
HEATING OF HEAVY IONS ON AURORAL FIELD LINES IN THE PRESENCE OF A LARGE AMPLITUDE HYDROGEN CYCLOTRON WAVE
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Heating of heavy ions is studied analytically and by means of numerical simulations in the presence of a large amplitude hydrogen cyclotron wave which is commonly observed on auroral field lines. Both one- and two-dimensional numerical simulations showed a decay instability resulting in strong heating of both the oxygen ions and the hydrogen ions. In particular, detailed results of simulations in two dimensions where $\vec{E} \times \vec{B}$ drift plays an important role indicate a much stronger heating of the oxygen ions than that in the one-dimensional simulation. A high energy tail of the oxygen ions is commonly observed in the perpendicular distribution.
J. Geophys. Res., A, Paper 4A8203.

5760 Plasma motion, convection, or circulation
ENHANCED ION OUTFLOWS MEASURED BY THE DE-1 HIGH ALTITUDE PLASMA INSTRUMENT IN THE DAYSIDE PLASMASPHERE DURING THE RECOVERY PHASE
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Ion flow velocities both parallel and perpendicular to the magnetic field and including the effects of spacecraft charging and spacecraft velocity have been measured during the recovery phase of two large magnetic storms on October 14 and 21 of 1981. These measurements were made both inside and outside the plasmasphere and indicate unreported yet substantial outflows of ions within the dayside plasmasphere (October 14). Combined data from instruments on board the Dynamics Explorer satellite including the High Altitude Plasma Instrument (HAPI), the Energetic Ion Composition Spectrometer (EICS), the Retarding Ion Mass Spectrometer (RIMS) and the Plasma Wave Instrument (PWI), indicate that those ions are most likely dominantly O+ at energies at least as low as 5 eV. The nightside pass (Oct. 21), which occurred during the recovery phase of a similar storm, showed no plasmaspheric outflows. The results indicate that a large contribution to the outflux into the dayside plasmasphere [illegible] eV ions.
J. Geophys. Res., A, Paper 4A8144.

5760 Plasma Convection
MAGNETOSPHERIC CONVECTION OBSERVED BETWEEN 06 AND 21 LT: VARIATIONS WITH Kp
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Using data from the GEOS-2 electron gun experiment we have constructed average patterns of the convective flow of plasma in the equatorial plane at L = 6.6 between 06 and 21 LT and for Kp ranging between 0 and 4. During very quiet conditions (Kp = 0-1) the plasma flows predominantly westward with an outward component before noon and an inward component thereafter. The most likely dominant agent for this kind of convection is the atmospheric dynamo electric field. For moderate activity (Kp = 3-4) the plasma flows as predicted by a Volland-Stern-type dawn-to-dusk cross-tail electric field model (if the atmospheric dynamo effect is subtracted) with a shaping factor close to 3 and the axis of symmetry rotated towards earlier local times. The shielding of the cross-tail electric field from the inner magnetosphere seems to be somewhat weaker on the dayside than on the eveningside. During times of Kp = 2 sunward convection and atmospheric dynamo effect seem to compete, i.e. sunward convection prevails but our average pattern apparently is still substantially influenced by the atmospheric dynamo field.
J. Geophys. Res., A, Paper 4A8199.

5763 Plasmapause
THE EFFECT OF HYDROMAGNETIC WAVES ON THE SHAPE OF THE PLASMAPAUSE BOUNDARY
R. A. Daly and W. J. Hughes (Department of Astronomy, Boston University, Boston, MA 02215)
We show that hydromagnetic wave electric fields could cause the fluctuations in cold plasma number density that have been observed as spacecraft cross the plasmapause. To explore the effects of a hydromagnetic wave electric field on the particles in the vicinity of the plasmapause we constructed a simple computer model of the flow of cold plasma in the equatorial plane of the magnetosphere. A hydromagnetic wave electric field which is localized in space and time is introduced. Particles are perturbed by the wave electric field. The resulting fluctuations in cold plasma number density are most evident in the dusk region and occur over both large (≈ 1 R_E) distance scales. As these variations in the number density are similar to those observed, hydromagnetic wave electric fields could very well account for the density variations observed in the vicinity of the plasmapause boundary.
J. Geophys. Res., A, Paper 4A8094.

5799 General (Charged Dust)
THE STABILITY OF THE OSCILLATION MOTION OF CHARGED GRAINS IN THE SATURNIAN RING SYSTEM, R.-L. Xu and Harry L. F. Houpis, (Department of Electrical Engineering and Computer Sciences and the Center for Astrophysics and Space Science), University of California, San Diego, La Jolla, CA 92093,
The stability of charged grains given a random initial velocity is determined by a perturbation approach for the gravito-electrodynamic forces encountered in the co-rotating plasma environment of Saturn. Saturn's magnetic field is assumed to be a dipole with a small northward offset. If the equatorial component of the grain's initial velocity is given a specific value V_{s0}, the general results of two previous theories (Northrop and Hill, 1982; Mendis, Houpis and Hill, 1982) are reproduced, including the critical radius for z-instability at 1.616 R_s. However, for initial velocities other than V_{s0}, a large spectrum of new results occur. Here we discuss the implications of these results for the formation of the Saturnian ring system. In particular, we suggest that the marginal z-stability radius at 1.5245 R_s for Kepler launched particles is due to an erosion process with ejecta on the order of .05 - .5µ rather than that of plasma as previously suggested. The diffuseness of the Saturnian rings beyond the F-ring is also explained in terms of instability, while a new critical radius for r-instability is suggested for the optical depth feature at 1.72 R_s. Finally, the F-ring is analyzed in detail. (Charged grains, stability, Saturn's rings.)
J. Geophys. Res., A, Paper 4A8184.

5799 General (Ionospheric modification experiments)
THE TEMPORAL EVOLUTION OF THE THREE-METER STRIATIONS IN THE MODIFIED IONOSPHERE
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Experiments were performed at Arecibo, Puerto Rico to investigate the evolution times of three-meter field-aligned striations produced in the ionosphere by powerful high frequency (HF) radio waves. The results of this investigation are now summarized. First, the striations' rise times are dependent on the HF electric field. The E region data suggest that this dependence is non-linear. Second, the threshold value of the HF electric field required to produce detectable striations was experimentally determined. At threshold, the component of the HF electric field perpendicular to the geomagnetic field is calculated to be 0.09 V/m in the F region and 0.37 V/m in the E region. Third, both the E and the F region data verify theoretical predictions that the striations' decay times are directly proportional to the electron diffusion across $\vec{B}$. Finally, a one-to-one correspondence between the growth of the three-meter striations and the decline of the HF-enhanced plasma line during overshoot is sometimes observed. (Striations, HF-heating, threshold measurements)
J. Geophys. Res., A, Paper 4A1245.

Planetology

6510 General (Limb Inversion)
RETRIEVAL OF NON-LTE VERTICAL STRUCTURE FROM A SPECTRALLY RESOLVED IR LIMB RADIANCE PROFILE
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An algorithm is described for retrieving vertical profiles of a non-LTE radiator (lower and upper state densities) and temperature from a spectrally resolved profile of infrared limb radiance. The limb radiance profile integrated over an optically thin line or region of the spectrum can be expressed as an Abel integral equation that may be solved for the vertical profile of volume emission rate. The volume emission rate profiles thus obtained from two or more thin spectral lines or regions representing a single species are used to solve for the vertical profiles of translational temperature and excited state molecular density. These two solutions and the limb radiance profile for non-thin spectral lines or regions are used in a nonlinear recursion scheme to obtain the species vibrational temperature profile. Results obtained in a numerical simulation using the ν_2 band of CO_2 are presented to demonstrate the method and, in particular, the convergence properties of the relaxation technique for recovery of vibrational temperature. (Limb inversion, atmospheric IR emission, non-LTE conditions).
J. Geophys. Res., A, Paper 4A8064.

6510
ORIGIN OF OLIVINE AT COPERNICUS
C.M. Pieters (Department of Geological Sciences, Brown University, Providence, Rhode Island 02912), and P.E. Wilhelms
The central peaks of Copernicus are among the few lunar areas where near-infrared telescopic reflectance spectra indicate extensive exposures of olivine. Other parts of Copernicus crater and ejecta, which were derived from highland units in the upper part of the target site, contain only low-Ca pyroxene as a mafic mineral. The exposure of compositionally distinct layers including the presence of extensive olivine may result from penetration to an anomalously deep layer of the crust or to the lunar mantle. We suggest that the Procellarum basin and the younger, superposed Insularum basin have provided access to these normally deep-seated crustal or mantle materials by thinning the upper crustal material early in lunar history. The occurrences of olivine in portions of the compositionally heterogeneous Aristarchus Region [illegible] of early events. (Copernicus crater, Procellarum basin).
J. Geophys. Res., B, Paper 4B5822.

6560 Meteorites
THE POLYMICT EUCRITES
J. S. Delaney (Department of Mineral Sciences, American Museum of Natural History, New York, NY 10024), M. Prinz and H. Takeda
The polymict eucrites are a suite of about 14 polymict achondritic meteorites that contain at least 90%(vol.) of eucritic material and are found both in Antarctica and elsewhere. They are part of a continuum of polymict breccias that includes howardites and polymict diogenites. Rare gas data suggest that some are gas-rich regolith breccias. The clasts contained in polymict eucrites sample a variety of lithologies from their parent body and include eucritic clasts, alkali-enriched eucrites, pyroxene-cumulate eucrites, two-pyroxene mafic rocks, possibly feldspar-cumulate eucrites, diogenites, fayalitic lithologies, and a variety of other mineral clasts. The eucritic clasts are probably samples of near surface lithologies on the parent body, but the presence of two-pyroxene mafic rocks is considered to be evidence of magmatic activity at pressures in excess of 1 kbar in the parent body. Partial melt models may explain some of the diversity among the clasts but cumulus processes are believed to have been important. If pressures greater than 1 kbar are confirmed then the basaltic achondrite parent body (BAP) must have a diameter in excess of 200 km. The variety of lithologies suggests that not all basaltic achondrites are samples of igneous rocks formed by single stage melting of a chondritic asteroid but are instead samples of an evolved and diverse crust produced by serial magmatism. (Polymict eucrites, basaltic achondrites, eucrites, howardites).
J. Geophys. Res., B, Paper 4B5855.

6599 General (Impact Cratering)
A GEOMETRIC MODEL FOR EXCAVATION AND MODIFICATION AT TERRESTRIAL SIMPLE IMPACT CRATERS
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A geometric model for the excavation and modification of simple crater development is presented. Modification is modelled by considering the relative dimensions and geometries of the final crater and the transient cavity formed by excavation and displacement. The input parameters required are the rim crest diameter of the final crater, the depth to autochthonous basement, the rim crest height and the outer rim slope. The model calculates the diameter of the final crater at the original ground plane, the dimensions of the transient cavity and the rim crest volume differences between the final and transient cavities. This volume is considered to be the material which slumped off the unstable, overheightened transient cavity wall during modification and corresponds to the observed volume of the breccia lens within the final crater. Excavation is approximated by a steady-state Z model, with the diameter of excavation equivalent to the previously modelled diameter of the transient cavity at the original ground plane, the center of flow taken as 1 projectile diameter, and Z = 2.5-3.0. The Z model predicts such parameters as the depth and volume of excavation, which can be compared with observational data. The applicability of the model has been tested with data from Meteor and Brent craters. In the case of Meteor, the modelled final crater diameter at the original ground plane is within 76 m of the observed value and the modelled breccia lens and the rim crest volumes of the final true crater are within 9.5% and 2.5%, respectively, of observed values. The results of the Z model for Meteor Crater, with Z = 2.8 ± 0.1 give results consistent with observational data on the depth and volume of excavation. The correspondence for the more degraded Brent crater is less precise, as there is greater uncertainty in the input parameters. It is possible, however, to match the model parameters with the breccia lens volume and published estimates of original dimensions. The modelled excavated volumes for Meteor and Brent are 58% and 55%, respectively, of the transient cavity volume below the original ground plane. In the absence of additional observational data for further testing, it is concluded that the model may provide first-order spatial information on the formation of simple craters. (Simple crater, excavation, modification, Z-model).
J. Geophys. Res., B, Paper 4B1022.